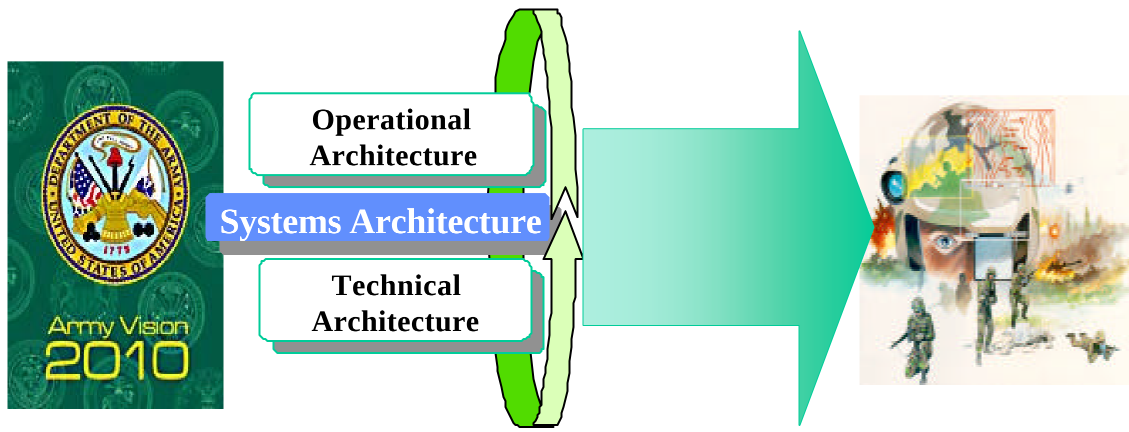
# Installation Information Infrastructure Architecture (I3A) Design and Implementation Guide

## 02 March 1999



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# 1 Introduction

1.1 Purpose. This document provides guidance for the planning, design, and implementation of the Installation Information Infrastructure Architecture (I3A) for Army installations in the Continental United States (CONUS).

1.2 Scope.

1.2.1 Integration of architectures throughout the United States Army and Department of Defense is essential. The I3A is a synchronization tool for major U.S. Army automation and communications programs (Figure 1-1: I3A Program Synchronization). The underlying objective is to meet current information transfer requirements while creating an infrastructure sufficiently flexible to meet the exponentially increasing future data communications requirements and to accommodate new technology advances. A long-term benefit of the I3A is the integration of telephone and data communications on a single network.

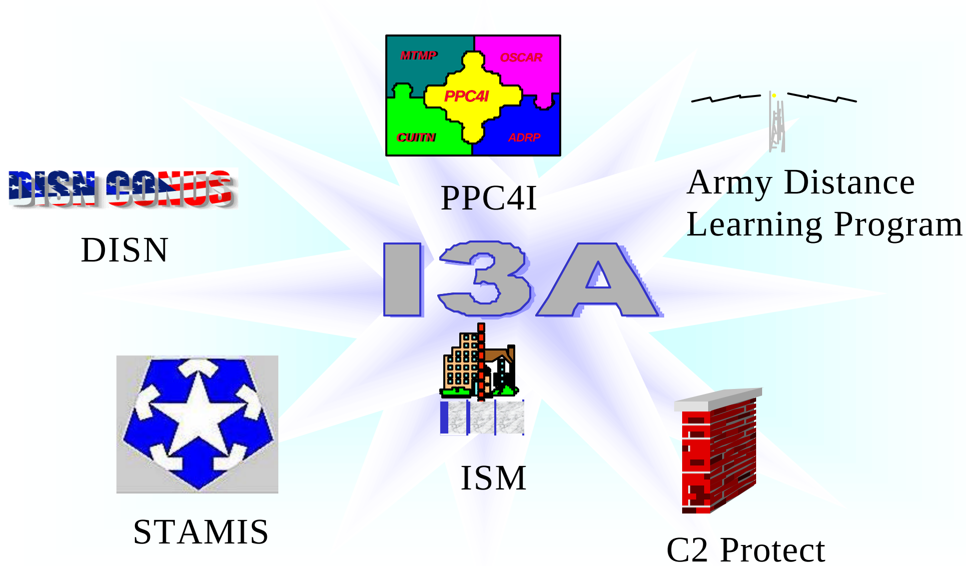



**Figure 1-1: I3A Program Synchronization**

1.2.2 Designers shall always review applicable policies and programs before planning their infrastructure or network. This ensures integration with current systems and will enable the designer to identify programs and standards up front that provide procedural or technical guidance. Planning includes identifying technologies and selecting the templates and topologies that best fit your installation requirements.

1.2.3 The Army's goal of a common, fully integrated, digital transfer system is expected in the 2010+ time frame with a Broadband-Integrated Services Digital Network (B-ISDN). Asynchronous Transfer Mode (ATM) is projected to be the communications infrastructure for providing this service. Thus, a currently installed ATM Network will positively influence the eventual migration to B-ISDN. B-ISDN will provide communication services for all types of data/information (e.g. voice data, image, and video). The I3A program will provide an infrastructure capable of supporting the integration of the voice telephone network and computer data networks. I3A is applicable to the design and engineering of new buildings and other projects under the Army military construction programs, as well as in the installation, rehabilitation, and replacement of current installation telecommunications infrastructure. This document is intended to support the necessary site surveys and analysis, which shall be done prior to actual engineering of solutions to accommodate unique requirements. This guide assists in the integration of the Outside Cable Rehabilitation-II (OSCAR-II), Common User Installation Transport Network (CUITN), Digital Switched Systems Modernization Program (DSSMP), Military Construction-Army (MCA), locally managed projects, and the Army Defense Information Systems Network (DISN) Router Program (ADRP). An I3A must be capable of connecting the tactical and sustaining base in support of the Army Warfighter as a key component of the Force Projection concept.

1.3 Document Content. This document will establish an implementation concept that can be used to shape architectural templates and influence the design process for the I3A. It will identify proven infrastructure construction techniques, define common practices, and serve as an authoritative implementation guide.

1.4 Background.

1.4.1 Faster processors, distributed client/server computing and new multimedia applications (e.g., tele-medicine, desktop video teleconferencing, and educational applications) are driving the enterprise network evolution. All require higher performance/throughput, greater network predictability, and higher network availability than is currently available in the existing communications infrastructure.

1.4.2 Installation networking engineers and designers face challenges such as systems integration, identifying the most efficient technologies, leveraging government contracts for purchasing equipment and determining which vendor's product is the most suitable. This document assists the planner in making informed decisions that are technically correct and financially feasible.

1.4.3 In the near-term, most users will have an analog telephone to a Narrowband-Integrated Services Digital Network (N-ISDN) switch for voice communications and a Local Area Network (LAN) connection for computer data communications. Using N-ISDN the user can conduct video teleconferencing calls worldwide. However, the supporting infrastructure must be capable of evolving to ATM signaling rates as the user requirements grow and the higher data transfer rates are needed to support the new services (e.g., video, multi-media, and teleconferencing).

1.4.4 The migration away from traditional shared media (hub/router) LANs to switched networks is one of the dominant trends in today's network market. The switched network provides higher performance and more predictable operation than a traditional shared media LAN using the Institute of Electrical and Electronic Engineers (IEEE) 802.3 and Fiber Distributed Data Interface (FDDI). The transition is already occurring in the installation backbone data network with the use of ATM cell switches at the Main Communications Node (MCN) locations. This migration is expected to continue as hubs in the End User Building (EUB) incorporate switching through high-speed backplanes and switching modules using standard protocols and mappings to ATM cell formats. This allows direct connection of the EUB switching hub to ATM cell switches at the Area Distribution Node (ADN). The router in today's network will then only be needed to interface with legacy shared media LANs. Under the DISC4 Network Security Improvement Program routers will also provide packet filtering for Wide Area Network (WAN) border security. This will be required even if you have a firewall. It should be noted that the speed of ATM will increase the speed of your network, but the network's full potential is limited as long as a router providing WAN border security and filtering remains. Finally, routers will provide policy enforcement between switched Virtual Local Area Networks (VLAN), making it possible to define who can communicate with whom and in what manner across a switched VLAN architecture. Figure 1-2: I3A Integrated Layout demonstrates how voice and data are integrated across the I3A.

1.5 DoD Architectural Standards. The DoD has established a broad body of guidance on information technology standards, architecture, and design. This guidance is incorporated in a hierarchy of standards and architectural guidance documentation that is available on the World Wide Web (WWW).

1.6 DoD Directives (DoDD) and DoD Instructions (DoDI). In addition to the hierarchy of architectural standards outlined in the preceding paragraphs, DoD has created and implemented detailed guidance regarding interoperability among Command, Control, Communications, and Intelligence ($C^3I$) systems, and between these and systems tasked to support them. This I3A Design Guide is in compliance with all the Interoperability Policy Documents (http://jitc-emh.army.mil/ciidocs.htm).

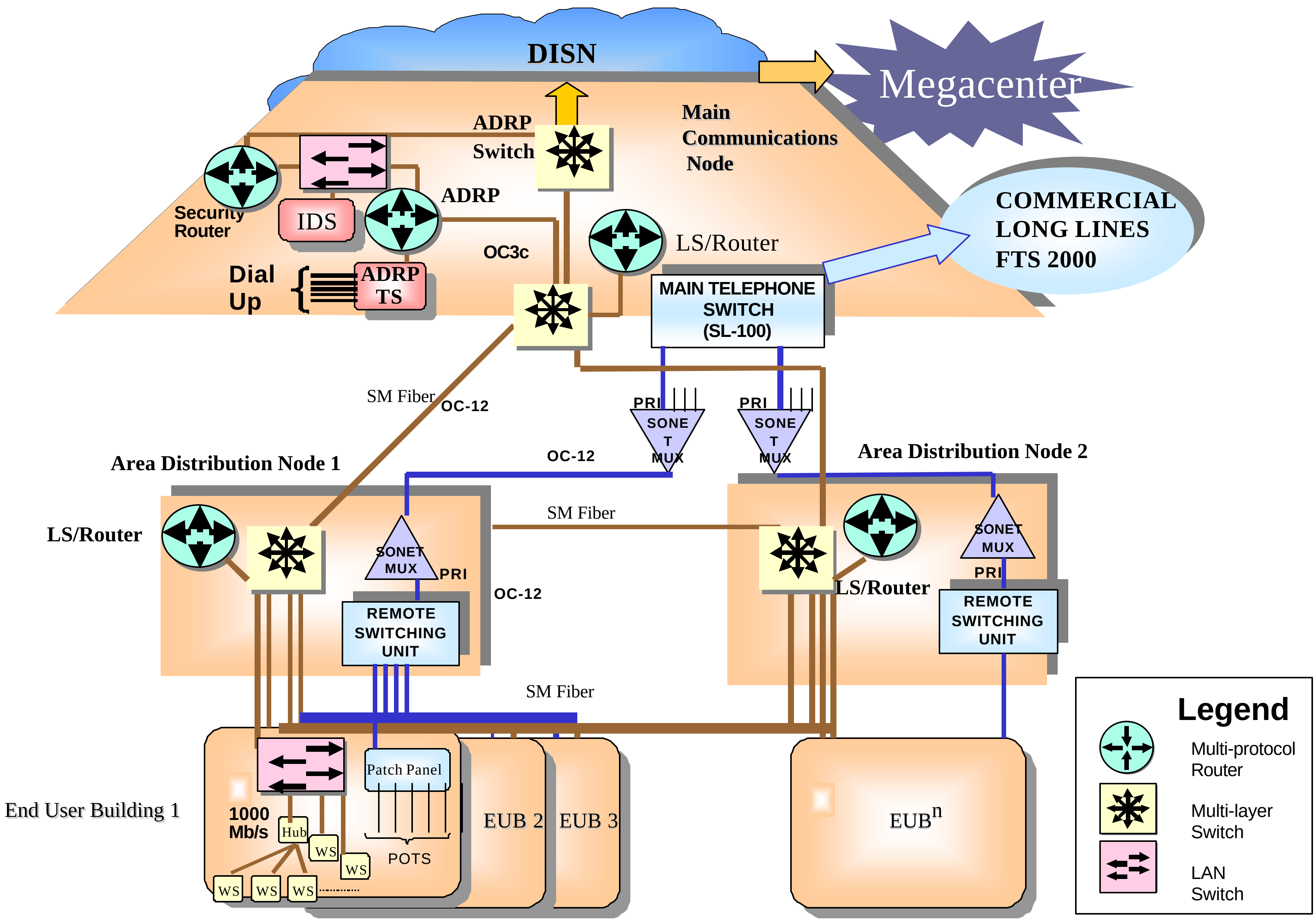



**Figure 1-2: I3A Integrated Layout**

# 2 Premises Distribution System (PDS).

2.1 The PDS is designed to satisfy I3A policy information system (IS) requirements within a facility. The PDS shall be installed in accordance with Telecommunications Industry Association (TIA) Electronics Industry Association (EIA) general guidelines with modifications and clarifications provided below. EIA/TIA specifications can be purchased at http://www.tiaonline.org/standards/searchnorder.html.

2.2 Workstation Outlet.

2.2.1 Outlet Box. For standard administrative and medical facility (hospital) outlets use a 4-11/16" by 4-11/16" double gang electrical box mounted flush with the wall surface. Double gang electrical boxes shall be full depth to provide dedicated space for current and possible future fiber optic cabling (FOC) installation. For single connector outlets, such as voice, data, cable television (CATV) or closed circuit television (CCTV), use a full depth, single gang, electrical box mounted flush with the wall surface.

2.2.2 Outlet Faceplate. For standard administrative outlets use a full (double gang) face plate with connector locations for all copper and (if used) FOC. Standard administrative outlets may, by specific user request, use single gang outlet faceplates in conjunction with a reducing ring. For single gang outlet boxes, use a single gang outlet faceplate with appropriate connector locations and, if required, mounting lugs for wall phones.

2.2.3 Outlet Connectors.

2.2.3.1 Copper Connectors. Copper connectors shall be EIA/TIA category 5 (CAT5), 8-pin/8-position insulation displacement terminations wired per T568A (default configuration) or T568B (if required to maintain system configuration uniformity, security or other user-specified reasons). Category 3 rated connectors shall not be used in new construction or rehabilitation projects. Copper connectors and plugs shall be unkeyed unless the user requires keyed connectors and plugs to maintain system uniformity, security, or other user specified reasons.

2.2.3.2 Fiber Optic Connectors. Fiber optic connectors shall be EIA/TIA "SC" type (default choice) or "ST" type (if required to maintain system configuration uniformity, security or other user specified reasons). EIA/TIA "SC" type connectors are preferred in new systems as the international standard now accepted by the Federal Government; "ST" type connectors are most commonly found in existing systems but as a design choice has been superseded by the "SC" type. Small form factor connectors (available from several manufacturers), offer a potential for significant installation cost reduction, however the EIA/TIA has declined to select any individual product for inclusion in the standards. Use of small form factor connectors shall be reserved for situations in which the requirement for reduced installation cost is the primary factor.

2.2.3.3 Coaxial Connectors. Coaxial connectors shall normally be "F" type connectors; use other type connectors (i.e.: BNC, etc.) only if specifically required by the user.

2.2.4 Outlet/Connector Markings. Each communications outlet shall have a unique identifying number. In the telecommunications closet (TC), this unique identifying number shall be associated with the position on the patch panel or cross connect to which the outlet is connected.

Each horizontal cable shall be labeled both at the outlet and patch panel or cross-connect position in the communications closet.

2.2.5 Outlet Types. The following outlet types are identified as commonly used in military construction projects. Sketches of these outlets are included on Figure 2-5: Telecommunications Outlet Types.

a) Administrative Outlet. Two 8-pin modular (RJ45 type) connectors in a single or double gang outlet faceplate, one connector dedicated to voice use and one dedicated to data use.

b) Administrative w/Fiber Outlet. Two 8-pin modular (RJ45 type) connectors in a single or double gang outlet faceplate, one connector dedicated to voice use and one dedicated to data use, and two fiber optic connectors, dedicated to data use. Use of administrative outlets with fiber optic connectors is at specific user request for each project.

c) Medical Facility (hospital) Outlet. Two 8-pin modular (RJ45 type) connectors in a double gang outlet faceplate, one unkeyed, dedicated to voice use, one keyed or unkeyed, dedicated to data use, and two dedicated blank positions for fiber optic connectors. Use of keyed modular connectors for data and installation of fiber optic connectors is at specific user request for each project.

d) Furniture Outlet. Three 8-pin modular (RJ45 type) connectors in a modular furniture outlet faceplate with outlet box extender, one connector dedicated to voice use, and two connectors dedicated to data use. Connector voice and data dedication may be reassigned as requirements dictate. Use of modular furniture outlets with fiber optic connectors is at specific user request for each project.

e) Wall Outlet. One 8-pin modular (RJ45 type) connector in a single gang outlet faceplate with mounting lugs dedicated to voice use.

f) Special Outlet (FAX, Counter Top, etc.). Configuration generally similar to administrative or wall outlets but dedicated to special use and mounted at special heights usually defined by user (i.e., wall outlet mounted at 18’’ (450mm) above finished floor, or administrative outlet mounted just above countertop level.)

g) Pay Phone Outlet. One 8-pin modular (RJ45 type) connector in a single gang outlet faceplate with mounting lugs dedicated to voice use.

h) Barracks Outlet. One 8-pin modular (RJ45 type) connector in a single gang outlet faceplate, dedicated to voice use.

i) Barracks Outlet (TRADOC Schools). Two 8-pin modular (RJ45 type) connectors in a single gang outlet faceplate, one dedicated to voice use and one dedicated to data use.

j) Barracks Outlet (Combination). One 8-pin modular (RJ45 type) connector in a single gang outlet faceplate, dedicated to voice use, and one “F” type connector, dedicated to CATV or CCTV use.

k) Coaxial Cable Outlet. One “F” type connector, dedicated to CATV, CCTV or other video or data use.

l) User Defined Outlet. Number and type of connectors as defined by user.

2.2.6 Outlet Density. For planning purposes, when actual outlet locations are not known and cannot be determined with available information, reasonably accurate total outlet count estimations can be obtained based on the size and dedicated usage of the space. Calculations are based on gross square footage (overall building footprint without deducting for hallways, equipment rooms, restrooms, etc.), and the average outlet density for that specific category of facility space. Currently, eight categories of facility space are identified, each with its own average outlet density. The factors fall within the ranges given in EIA/TIA 569A.

| | Facility Space Category | Area (SF) per Outlet |
|---|---|---|
| a. | Administrative Space (Shown on PDS-0002) | 80 |
| b. | Technical Space | 100 |
| c. | Clerical Space | 140 |
| d. | Classroom Space | 80 |
| e. | Barracks Space | 315 |
| f. | Warehouse Space | 5000 |
| g. | High Density | 50 |
| h. | Medical Space | 80 |
| i. | Other Space | 500 |

For Army Family Housing (AFH) Units, the number of rooms in the AFH unit determines minimum outlet quantities. In general provide one telephone outlet and one CATV outlet (as a minimum) in each of the following rooms: kitchen, living room, dining room, family room/area, each bedroom, and any other logical location deemed appropriate.

## 2.3 House Wiring

### 2.3.1 Horizontal Cable

2.3.1.1 Copper Voice and Data. Two CAT5, 4-pair 24 American Wire Gauge (AWG), 100 ohm, solid, unshielded twisted pair (UTP) cables shall be installed to each standard dual connector outlet and one CAT5, 4-pair 24 AWG, 100 ohm, solid, UTP cable shall be installed to each single connector outlet. Use only cable that has passed the Underwriters Laboratory (UL) LAN certification program, and is labeled with UL acceptable markings. Termination shall be performed using an 8-pin (RJ45 type) connector. All terminations shall be wired in accordance with EIA/TIA T568A. In a standard cabling scheme, horizontal cables are arbitrarily designated “voice” and “data” to identify and differentiate their purpose. Each voice outlet shall be assigned a unique telephone number in accordance with the single-line concept.

2.3.1.2 Fiber Optic Data. FOC to each outlet is optional at specific user request. As a minimum, administrative (including hospital) outlet boxes and faceplates shall be sized and configured to allow for the future installation of two strands of FOC. When the user requires FOC, multimode 62.5/125-micron cable shall be installed using duplex “SC” type connectors. Single-mode FOC and other type connectors may be substituted as required by the user.

2.3.2 Cable Length. Copper data cable length shall be limited to 295 feet from patch panel termination in the TC to the data outlet termination in accordance with EIA/TIA 568A. For planning purposes, in most administrative buildings where the TC is centrally located, assume an average of 120 feet of cable from the TC to each outlet. For non-administrative buildings (example: barracks), building renovations, or where the TC is not centrally located, adjust the average cable length for planning purposes as required (i.e., average measured length).

### 2.3.3 Vertical Riser Cable

2.3.3.1 Copper. Multi-pair voice riser cable shall meet the requirements of Insulated Cable Engineers Association (ICEA) S-80-576 and EIA/TIA-568-A for Category-3 100-Ohm unshielded twisted pair cable. Conductors shall be solid un-tinned copper, 24 AWG. The voice riser cable originating in the main telecommunications closet (TC) or main cross connect shall be terminated in each TC on 110 type punch blocks mounted on the telephone backboard. Provide at least two riser cable pairs for every outlet connected to the TC served by the riser cable. ICEA specifications are listed, and can be purchased at http://www.icea.net/document.htm.

2.3.3.2 Fiber Optic. A minimum of 12 strands of 62.5/125-micron multimode FOC and 12 strands single mode FOC shall be installed between the main telecommunications closet or main cross connect and each TC. The data FOC riser shall be terminated in a patch panel installed in an equipment rack or cabinet. If requested by the user, only 12 strands of one type of fiber may be used. The designer shall note that the network architecture recommends single mode FOC between TCs.

2.3.4 Coaxial Cable. When CATV or CCTV requirements are identified, either a broadband coaxial cable or single-mode FOC system shall be installed. When a coaxial system is installed, care shall be taken to ensure the correct cable is used. The table below lists cable type with corresponding distance limitation. This table is derived from vendor specifications (Anixter) for coaxial cable.

| Cable | Distance |
|---|---|
| RG-59 | <=150 feet |
| RG-6 | <=250 feet |
| RG-11 | <=400 feet |

2.3.5 Building Infrastructure. See Figure 2-2: Telecommunications Closet/Premise Distribution and Figure 2-3: Telecom Room/Supporting Structures for details.

2.3.5.1 Cable Tray. Solid bottom cable tray shall be used to provide a centralized cable management/distribution system. See Figure 2-2: Telecommunications Closet/Premise Distribution for details. Provide a cable tray with one square-inch of cross-sectional area per outlet location to be served. [For 30 outlets – a 9” by 4” = 36 square-inches cable tray would be satisfactory.] During actual design, an optimal fill ratio of 40% shall be planned for; under no circumstances shall the fill ratio exceed 60%. Ladder cable tray shall be avoided.

2.3.5.2 Enclosed Duct (Raceway). When a building design does not provide for installation of cable tray, enclosed square duct may be installed. Enclosed duct may also be used in place of cable tray when cable plant requires physical security. For initial design guidance, provide 1 square inch of cross-sectional area of the enclosed duct per outlet location. During actual design, an optimal fill ratio of 40% shall be planned for; under no circumstances shall a fill ratio of 60% be exceeded.

2.3.5.3 Conduit. Electrical metallic tubing (EMT) conduit shall be installed from the cable’s backbone distribution system, whether cable tray or enclosed duct, to each outlet. Conduit for standard outlets shall be a minimum of 1-inch EMT conduit. When cable tray or enclosed duct is not used, individual conduits shall be installed from the TC to each outlet. Where FOC is not initially installed to the standard dual connector outlets, a pull line shall be installed in each conduit. An optimal conduit fill ratio of 40% shall be planned for; under no circumstances shall a fill ratio of 60% be exceeded.

2.3.5.4 Pull Cord. All empty conduit routed to outlet boxes shall be provided with a pull cord. All 1-inch conduit containing only copper communications cabling routed to administrative and hospital outlet boxes shall be provided with a pull cord for future installation of FOC.

2.3.5.5 Pull Boxes. Pull boxes shall be placed in conduit runs where a continuous conduit length exceeds 100 feet, or where there are more than two 90-degree bends. Pull boxes shall be placed in straight, aligned runs of conduit and not be used in lieu of a bend.

2.3.5.6 Systems Furniture Wiring. The use of interconnected Systems Furniture has become more prevalent in the current office environment, and presents some unique challenges for the telecommunications designers and implementers. Although systems furniture is designed for quick reconfiguration of office space, experience has shown that power and telecommunications connections within the system furniture cannot be reconfigured easily.

2.3.5.6.1 Direct Connection. Figure 2-6: Systems Furniture Wiring shows two possible solutions for direct wiring to the systems furniture. This concept is one of a continuous home run from the TC to the furniture outlet. Continuous runs allow flexibility in cabling. Testing of the installed cable plant is simplified by providing an end-to-end circuit, without an additional connection point.

2.3.5.6.2 Multi-User Telecommunications Outlet Assembly (MUTOA) or Consolidation Point (CP). TIA/EIA TSB 75, Additional Horizontal Cabling Practices for Open Offices, allows for MUTOA or CP. These options provide greater flexibility in an office that is frequently reconfigured, but do introduce an additional connection and point of loss. If the MUTOA or CP is used, it shall be sized to support the number of users in the area plus 25%.

2.3.5.6.3 Protection and Separation. The implementers shall ensure that the cable is protected at all transition points, and that metallic separation is provided between telecommunication and power wiring in the power pole and/or systems furniture track.

2.3.5.7 Optional PDS Items. See Figure 2-7: Supporting Structure for Renovations for details. In new construction, particularly in large administrative or medical facility buildings, cable distribution systems shall use the cable tray (or duct) and conduit systems as described. In new construction involving small, mixed use (non administrative) facilities, or construction projects involving renovation of existing buildings, use of “J” hooks, flexible cable tray, and alternative support systems specifically certified for CAT5 cable is permissible. Polyvinyl Chloride (PVC) surface mounted duct shall be used in renovation projects where access to the walls for installation of conduit and outlet boxes is not possible, or where historical requirements prohibit the alteration of the building structure.

2.4 Telecommunications Closet. See Figure 2-2: Telecommunications Closet/Premise Distribution, Figure 2-3: Telecom Room/Supporting Structures, and Figure 2-4: Small Building/Premise Distribution for sample closet layouts.

2.4.1 Multi-Story Buildings. In multi-story buildings, a minimum of one TC shall be located on each floor (small facilities, i.e., air traffic control towers, firing ranges, etc., may use one TC for the entire facility). TCs on successive floors shall be vertically stacked wherever possible. A minimum of three 4-inch rigid steel conduits shall be installed between stacked closets on successive floors, in accordance with EIA/TIA 569A.

2.4.2 Closet Sizing. TCs shall be sized in accordance with EIA/TIA 569A for all new construction projects with primarily administrative function (small mixed-use facilities shall not require full compliance with EIA/TIA 569A). Generally, the TC shall be sized to approximately 1.1% of the area it serves. For example, a 10,000 square foot area shall be served by a minimum of one 110-square foot TC. TC sizing allowances shall be made only in cases of construction projects involving building renovation, and under no circumstances shall a closet be smaller than 70 square feet (7’ x 10’).

2.4.3 Closet Interior Finishes. Floors, walls and ceilings shall be treated to eliminate dust. Finishes shall be light in color to enhance room lighting.

2.4.4 Closet Door. TC doors shall be a minimum of 36” wide, 80” tall, hinged to open outward (or slide side to side) and be fitted with a lock to control access to the room.

2.4.5 Closet Location. TCs shall be dedicated spaces not shared with other functions (i.e., electrical rooms, mechanical rooms, etc). TCs shall be located centrally in the area they serve. TCs shall be located such that maximum copper cable distance from the patch panel through the structured cabling system to the furthest outlet does not exceed 295 feet. In rehabilitation projects, rooms containing transformers, air handling units, etc., shall be avoided if at all possible.

2.4.6 Telephone Backboards. See Figure 2-2: Telecommunications Closet/Premise Distribution and Figure 2-4: Small Building/Premise Distribution for sample backboard layouts. In new construction and in existing renovation when possible, telephone backboards shall cover a minimum of two walls in the TC. Backboards shall be ¾-inch thick and 96 inches tall, finished with a fire resistant coating and rigidly attached to the wall to support all attached equipment. When renovating an existing closet that does not have adequate space, the backboard shall be sized as large as possible to accommodate the protected entrance terminal (PET) and 110-type blocks.

2.4.7 Equipment Racks. Equipment racks shall be floor mounted 19 inches wide located at or near the center of the TC. If mounting requirements for oversize equipment are anticipated, 23 inches may be substituted. In narrow or crowded closets, equipment racks may be floor mounted adjacent to a wall, but shall provide a minimum 36 inches space both in front and in back of the rack.

2.4.8 Equipment Cabinets. Equipment cabinets shall be used to mount secure or mission critical equipment or in circumstances where controlled access is desired, such as CATV or CCTV distribution in barracks. Cabinets shall provide, at a minimum, sufficient space for current and anticipated future equipment requirements. Equipment cabinets may be floor or wall mounted and shall be logically grouped based on the purpose of the equipment they enclose.

2.4.9 Cable Rack. Channel type cable rack shall be used in the TC to provide distribution between the telephone backboard, equipment racks, riser conduits, and the distribution cable tray.

2.4.10 Closet Lighting. Light fixtures shall be mounted a minimum of 102 inches above the finished floor and provide a minimum of 50 foot candles of illumination measured 39 inches above the finished floor.

2.4.11 Closet Climate Control. Each TC shall be independently climate controlled, capable of providing cooling year round to protect all installed electronic equipment. Rooms shall be provided with positive atmospheric pressure to exclude dust.

2.4.12 Closet Contaminants. Information system equipment shall not be installed in spaces where moisture, liquid or gaseous spillage, or other contaminants may be present.

2.4.13 Electrical Power. A minimum of two dedicated 15-ampere, 110-volt alternating current (AC) outlets shall be installed with each equipment rack or cabinet to provide power for the installed equipment. An additional outlet shall be placed on each wall in the telecommunications closet.

2.4.14 Voice Communications. Each TC shall have one wall mounted telephone installed at or near the entry door.

2.4.15 Grounding. All TCs shall be connected to a single point building ground in accordance with EIA/TIA 607.

2.5 Cable Terminations. See Figure 2-1: Premise Distribution.

2.5.1 Copper Termination. All copper distribution cable used for voice or data circuits shall be terminated at the TC on 110-type CAT5 compliant termination panels mounted in an equipment rack (very small installations, i.e., one or two phones, can use a EIA/TIA Category qualified block).

a) Voice and data cables shall normally be terminated on the same patch panel or block and individually identified. Note: in the standard cabling scheme, the designations "voice" and "data" are arbitrary and do not imply that one outlet is better than the other – the outlets are identical in capability.

b) Where physical security is required, or by specific user request, data cable may be terminated in an enclosed 19-inch cabinet to provide enhanced protection for terminations, data equipment, and patching.

2.5.2 Copper Voice Patch Cables. Voice patch cables shall have a standard 8-pin/8-position (RJ45 type) connector on one end and a termination compatible with the incoming voice circuit block or panel on the other end. There is no requirement for voice patch cable to be CAT5 compliant.

2.5.3 Copper Data Patch Cables. Data patch cables shall be factory assembled 4-pair, stranded UTP, 24 AWG, CAT5 cable.

2.5.4 Fiber Optic Termination. All fiber optic distribution cable shall be terminated in rack-mounted patch panels. Duplex patch cables shall be used. Where required, and if space allows, all FOC shall be terminated in an enclosed 19-inch cabinet to provide greater protection for terminations, data equipment, and patching

2.5.5 Fiber Optic Patch Cables. Fiber optic patch cables shall be factory assembled using the same FOC type and connectors as the patch panels they are interconnecting.

2.6 Telecommunications System Labeling.

2.6.1 The telecommunications systems labeling shall be done in accordance with TIA/EIA 606. All outlets and patch panel positions shall be labeled as to their function and with a unique identifier code. All devices, outlet locations, and designations shall also appear on the system drawings. As a minimum the following shall be reflected in the outlet/patch panel labeling:

a) Security Level (if applicable).
b) Room Number.
c) Alpha or Numeric Designator.
d) Labeling shall be a minimum of ¼-inch high.

2.6.2 The labeling system used shall conform to any existing labeling, to the Director of Information Management (DOIM) standard, or if neither exist to the method described above. All designations shall be done in standard commercial labeling. Handwritten labels shall not be used for the final configuration.

2.6.3 Telecommunications Outlet Labeling. Outlet labeling shall be done in accordance with TIA/EIA-606. Each outlet location shall be labeled with a unique designator and level of classification, in sequence starting with “A” or “1” and proceeding clockwise around the room. The left 8-pin (RJ-45 type), CAT5 compliant connector shall be designated for voice and be labeled "VOICE." The right 8-pin (RJ-45 type), CAT5 compliant connector shall be designated for data and be labeled "DATA.” All LAN components in the system shall also be labeled with similar designations in accordance with TIA/EIA 606. The left or top 568SC FOC shall be labeled "A" and the right or bottom 568SC FOC shall be labeled "B."

2.6.4 Telecommunications Patch Panel Labeling. Patch panel labeling shall be done in accordance with TIA/EIA 606. Each position shall be labeled with a unique designator corresponding to the outlet location. The top or left 8-pin (RJ-45 type), CAT5 compliant port for each outlet location shall be designated for voice and be labeled "VOICE." The bottom or right 8-pin (RJ-45 type), CAT5 compliant port for each outlet location shall be designated for data and be labeled "DATA." Fiber-optic port labeling shall be done in accordance with TIA/EIA 606. The left or top 568SC port shall be labeled "A." The right or bottom 568SC port shall be labeled "B."

2.6.5 Distribution System Labeling. The distribution system as described in EIA/TIA 606 for pathways. In addition all transitions and changes in distribution system size and type shall be labeled. Each cabinet shall be labeled at the top with a unique designation.

2.7 Edge Device for Building. Power and possibly heating, ventilation, and air-conditioning (HVAC) must be available or obtainable before any equipment is considered.

2.7.1 Selection of Equipment. Selection of an edge device for an end user building (EUB) shall be based on the approved list of network devices, proposed or existing network architecture for that location and the user requirements. Additional considerations for selecting edge devices are whether the device supports LAN Emulation (LANE) and Multi-Protocol Over ATM (MPOA), and which versions of each are supported.

2.7.2 LAN Connectivity and Characteristics. Defense Data Network (DDN) hosts, mini or mainframe computers, E-Mail hosts, and departmental LANs located within EUBs shall be directly connected to the network backbone via the appropriate adapter cards in the ATM edge devices and an interface located in the TC. Area Distribution Nodes (ADNs) shall also house one-armed routers and LANE service devices when required for support of legacy LANs.

2.7.3 Connection to ADN/Main Communications Node (MCN). The ATM edge device located in the EUB TCs shall connect to the ATM switch at the ADN or MCN via OC-3c or higher links. The designer shall ensure that the edge device is fully compatible with the ATM switches in the ADN/MCN (LANE and MPOA).

## 2.8 Building Entrance Facility.

2.8.1 Definition. The building entrance facility (equipment room) is the demarcation point between the outside plant cabling and the inside plant distribution cabling.

2.8.2 Protected Entrance Terminals (PETs).

2.8.2.1 Protector Modules. The PET shall be equipped with gas modules to protect the inside plant wiring and equipment from power surges.

2.8.2.2 Twisted pair outside plant cable is terminated on the PET. See Figure 2-1: Premise Distribution and Figure 2-2: Telecommunications Closet/Premise Distribution for details. Cross connects can then be placed from the PET to the first set of 110-type terminal blocks as needed. The first set of terminal blocks provides connection for all risers and for outlets served by the main TC. For example, in a three-floor building, one tie cable shall be terminated on 110-type blocks on the same backboard as the PET; one tie cable shall be terminated on 110-type blocks in the 2nd-floor TC; and one tie cable shall be terminated on 110-type blocks in the 3rd-floor TC. A tie cable connects a second set of 110-type blocks in each TC to a rack mounted, 8-pin (RJ45 type) connector voice patch panel. This panel can be patched to the distribution patch panel, which in turn terminates the CAT5 outlet wiring. Cross connects can be done by the DOIM/Telephone personnel, and jumpers can be installed by the user/Information Mission Area (IMA) department, providing the desired connectivity between the outside plant and the inside plant wiring. This design allows maximum flexibility for future moves, adds, and changes.

2.8.2.3 Sheath Limitations. If the outside plant sheath distance from the building entrance point to the PET location is greater than 50 cable feet; the use of EMT is required.

2.8.2.4 Stencils. All PETs shall be stenciled with the terminal number and cable count.

2.8.3 Fiber Termination Device. Outside plant fiber optic cables are terminated on optical patch panels. The inside plant fiber optic riser cables are terminated on optical patch panels in the same or adjacent equipment racks. Patch cables are connected between the patch panels to provide the desired connectivity. All patch panels shall be stenciled with the panel number and the cable count.

2.8.4 Placement of Electronics. Electronic equipment shall not be placed in boiler rooms or other environmentally unsound locations. Common-user telecommunications equipment may be installed in the building entrance facility; however, many building entrance facilities do not have the environment control to support the operation of electronic communications equipment. If the building entrance facility does not have environmental control, the electronics shall be installed in the primary TC.

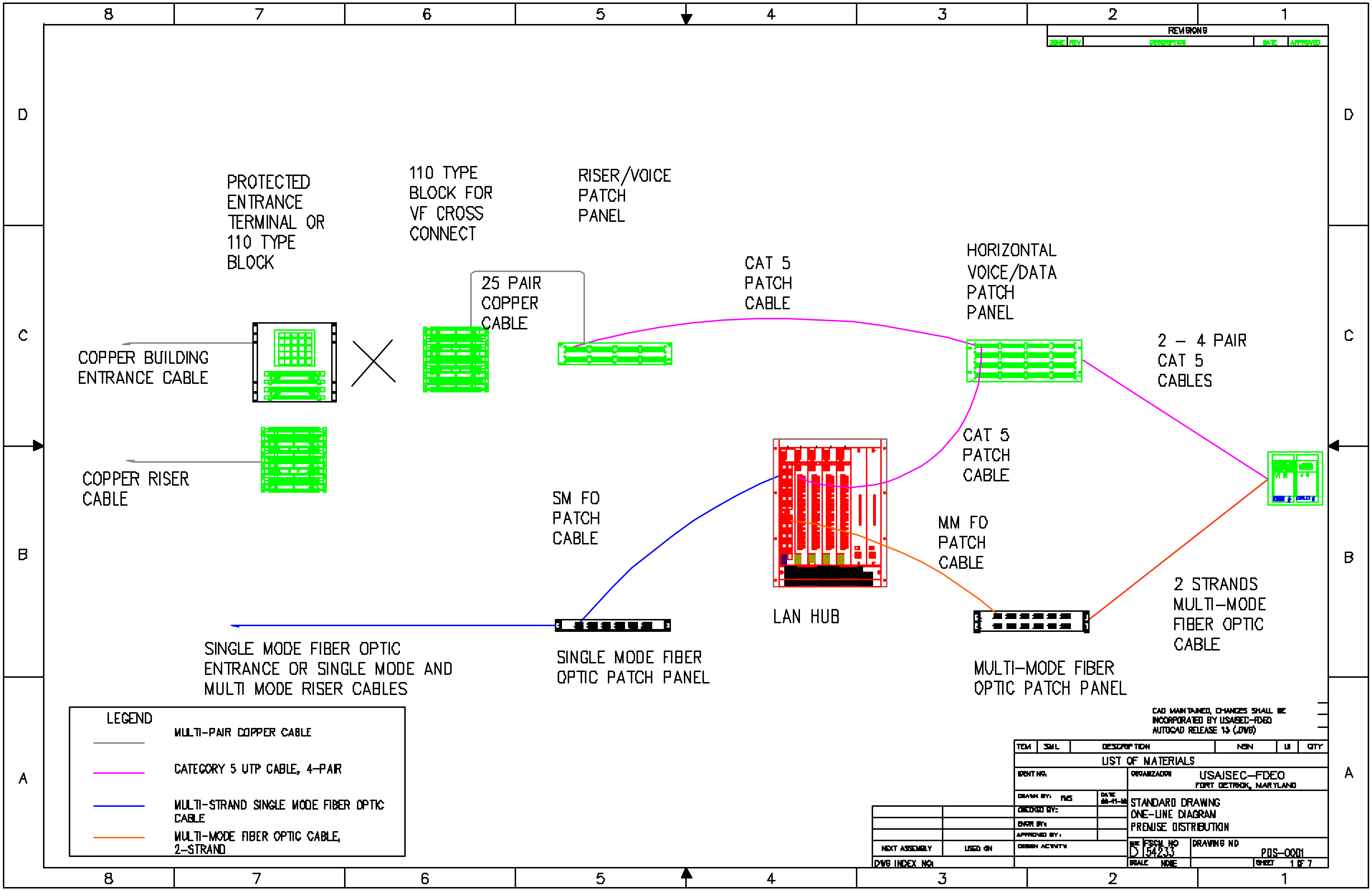



**Figure 2-1: Premise Distribution**

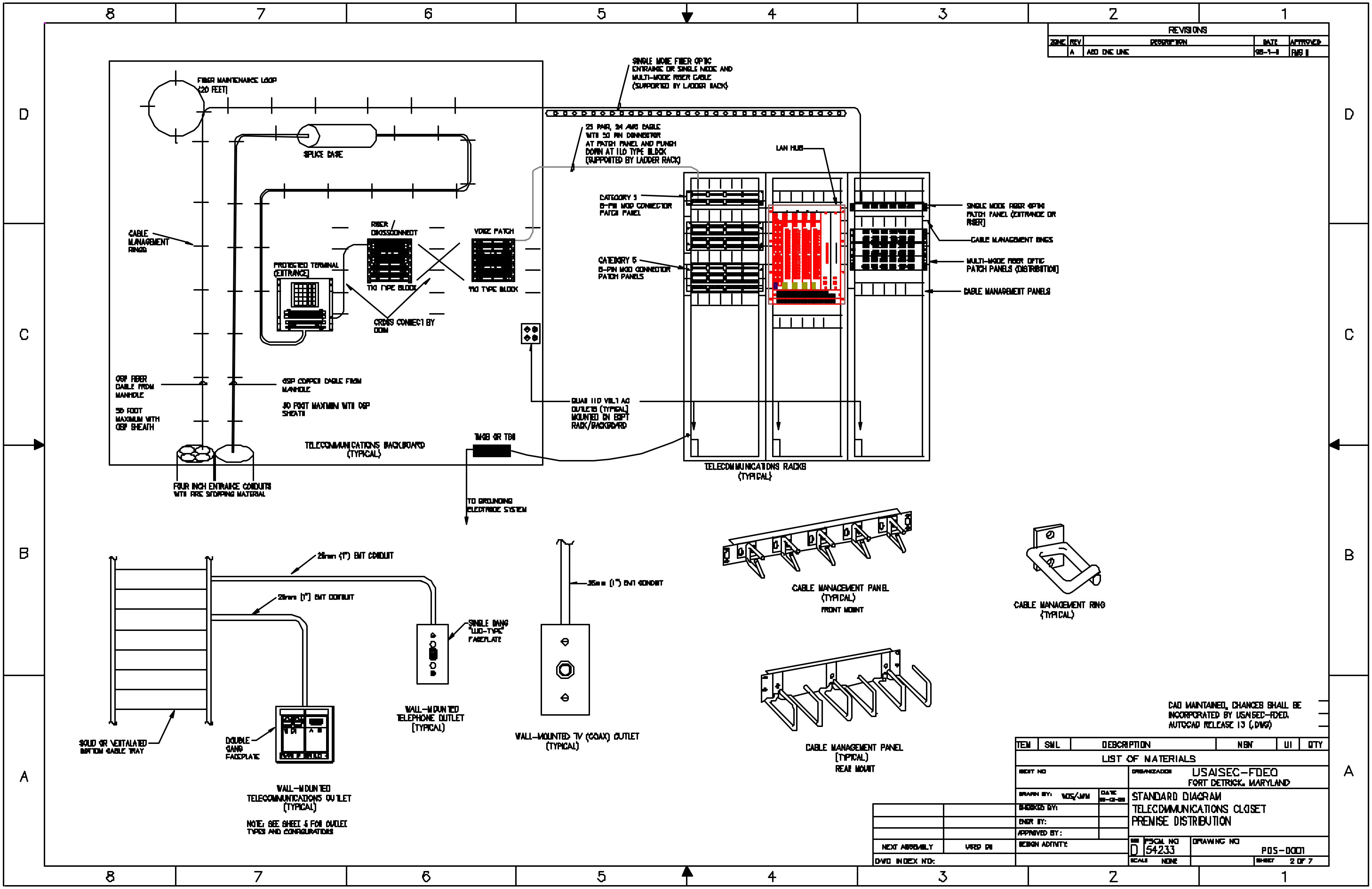



**Figure 2-2: Telecommunications Closet/Premise Distribution**

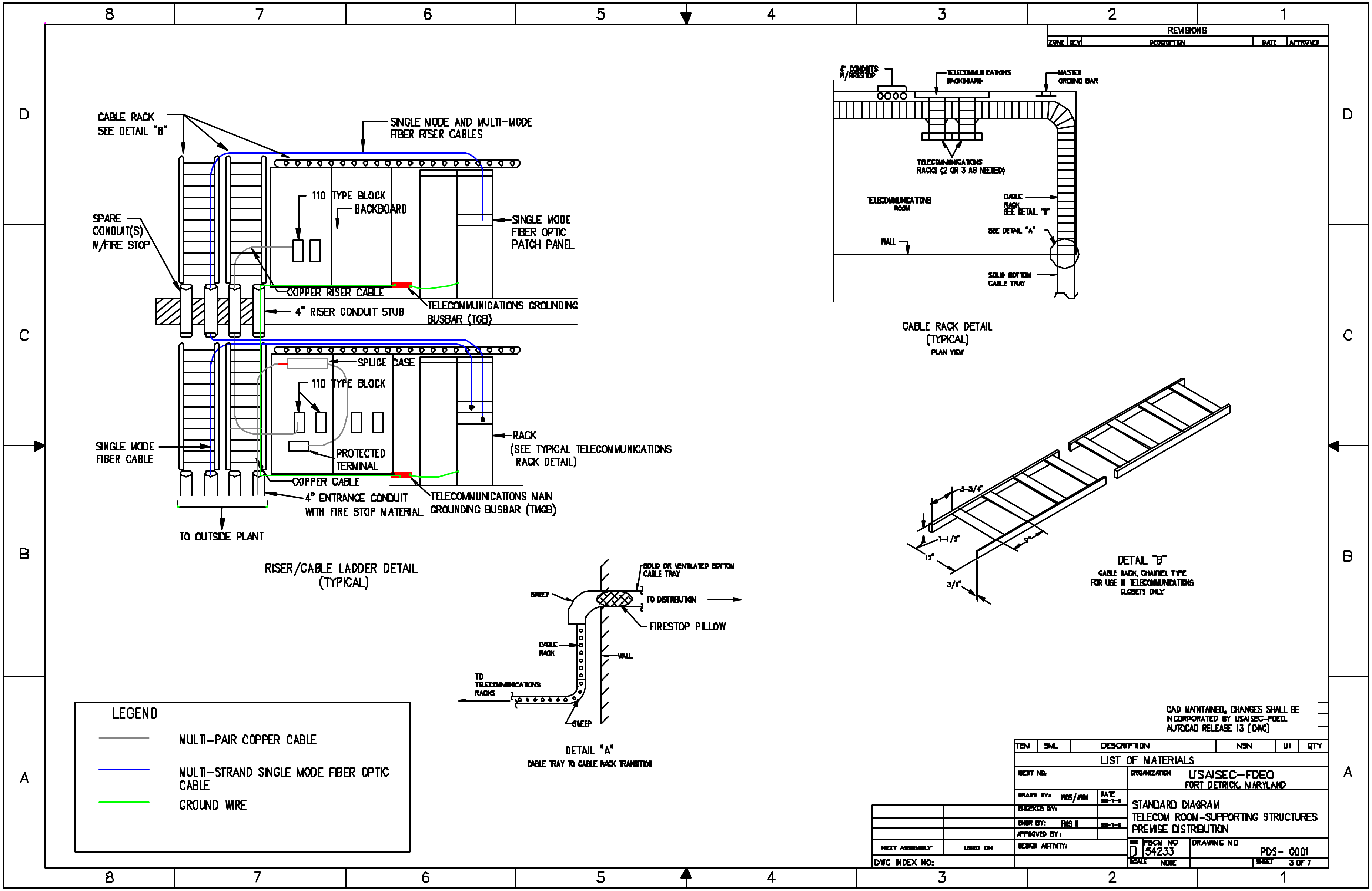



**Figure 2-3: Telecom Room/Supporting Structures**

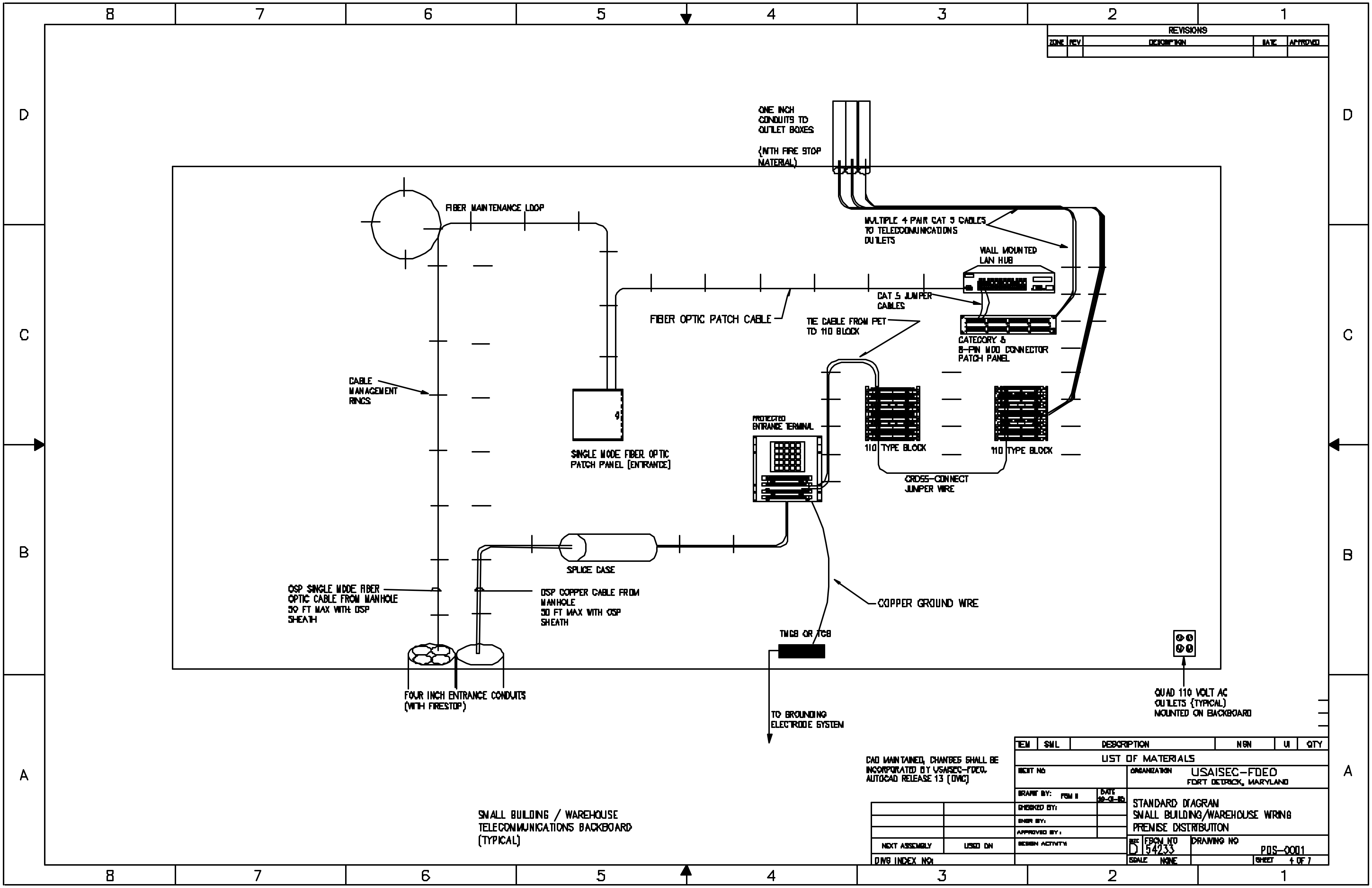



**Figure 2-4: Small Building/Premise Distribution**

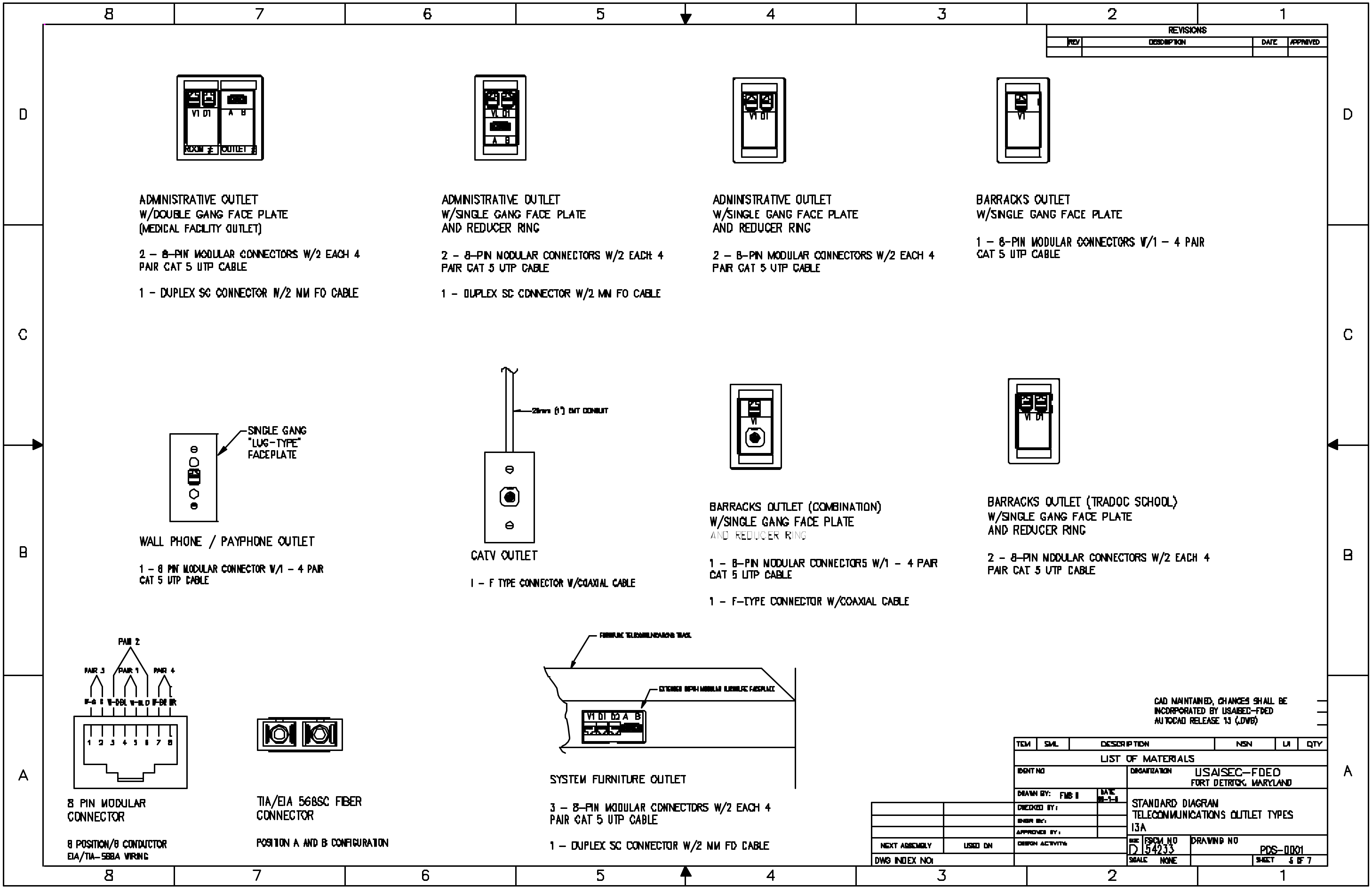



**Figure 2-5: Telecommunications Outlet Types**

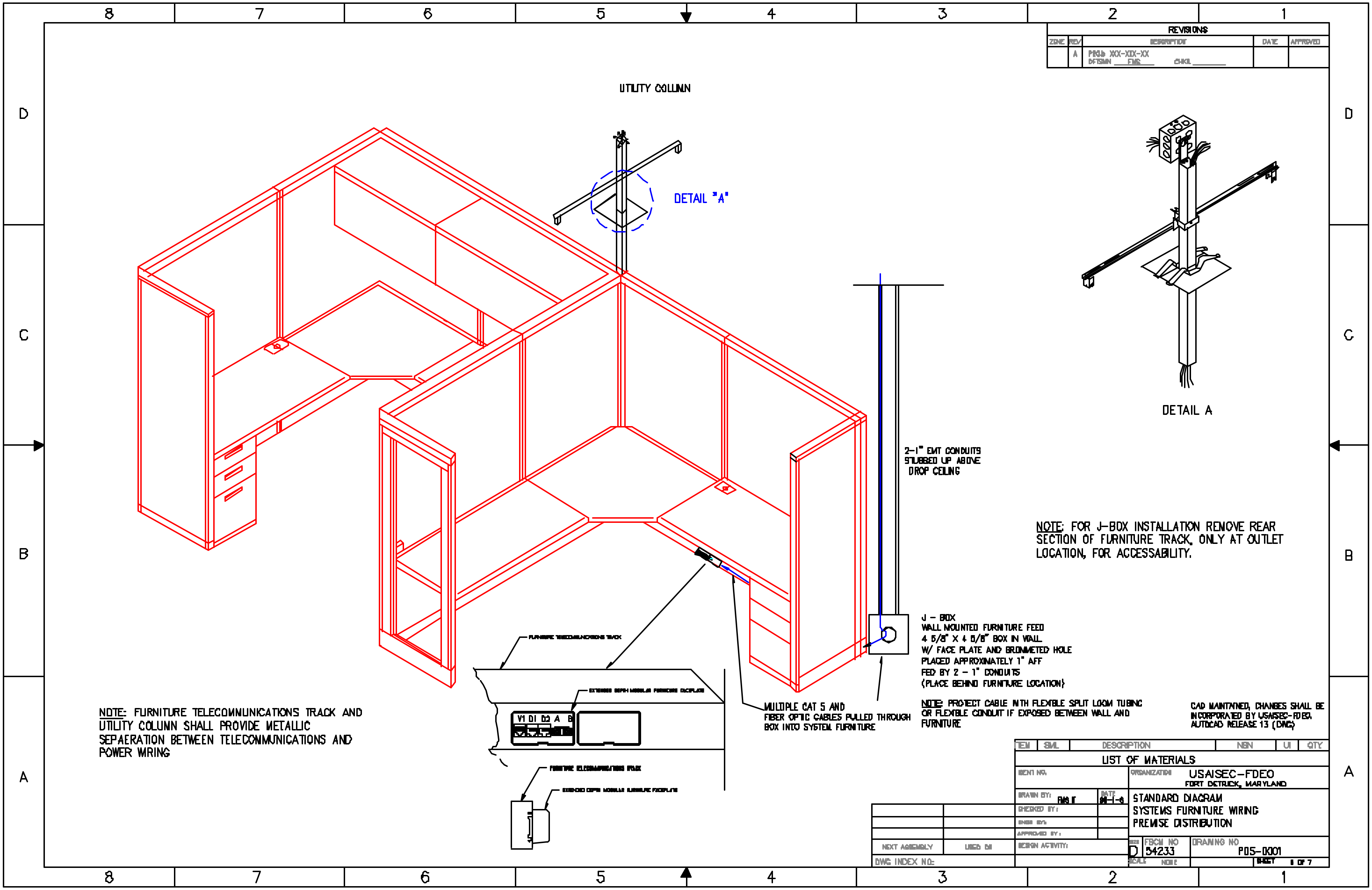



**Figure 2-6: Systems Furniture Wiring**

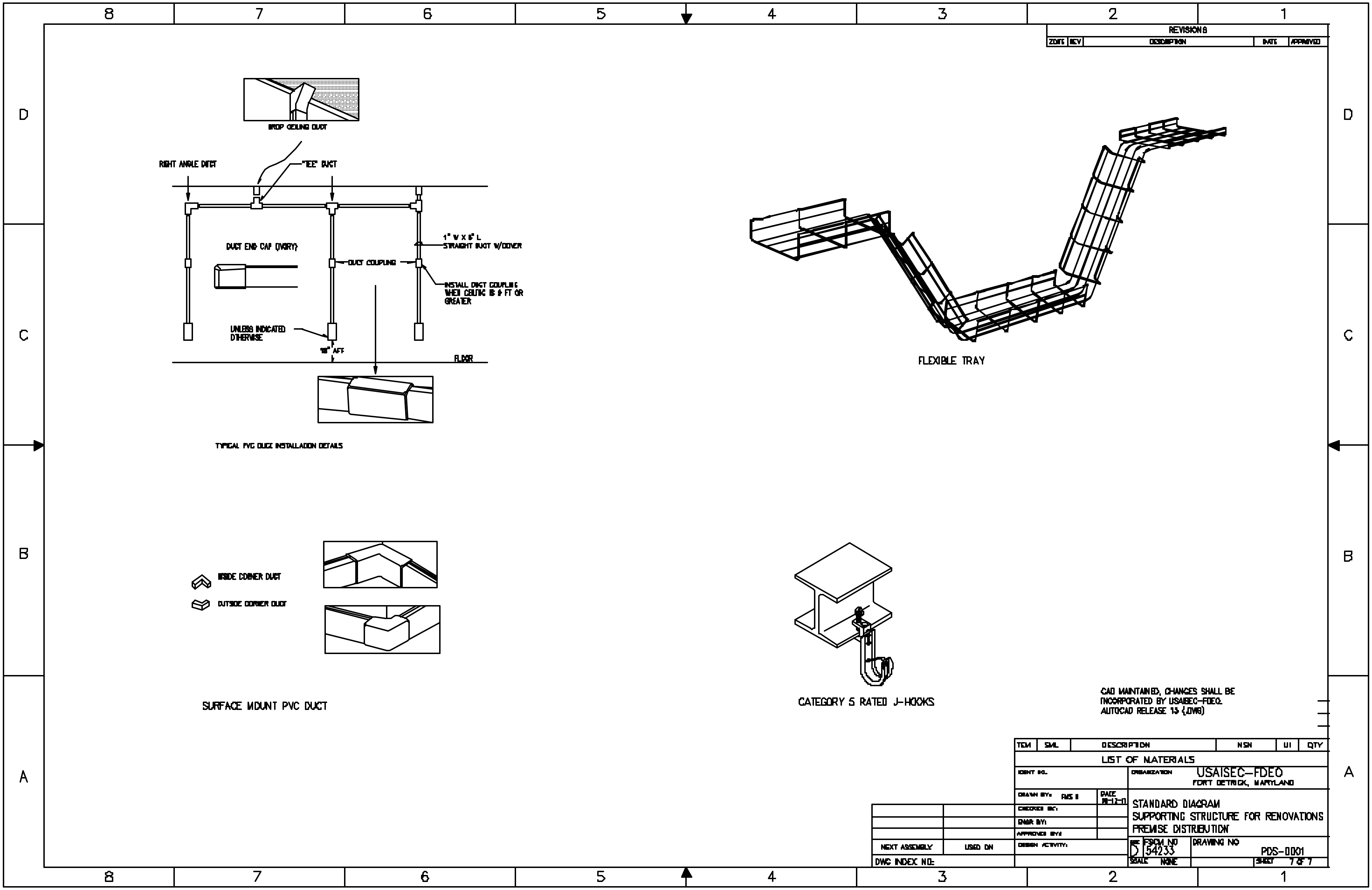



**Figure 2-7: Supporting Structure for Renovations**

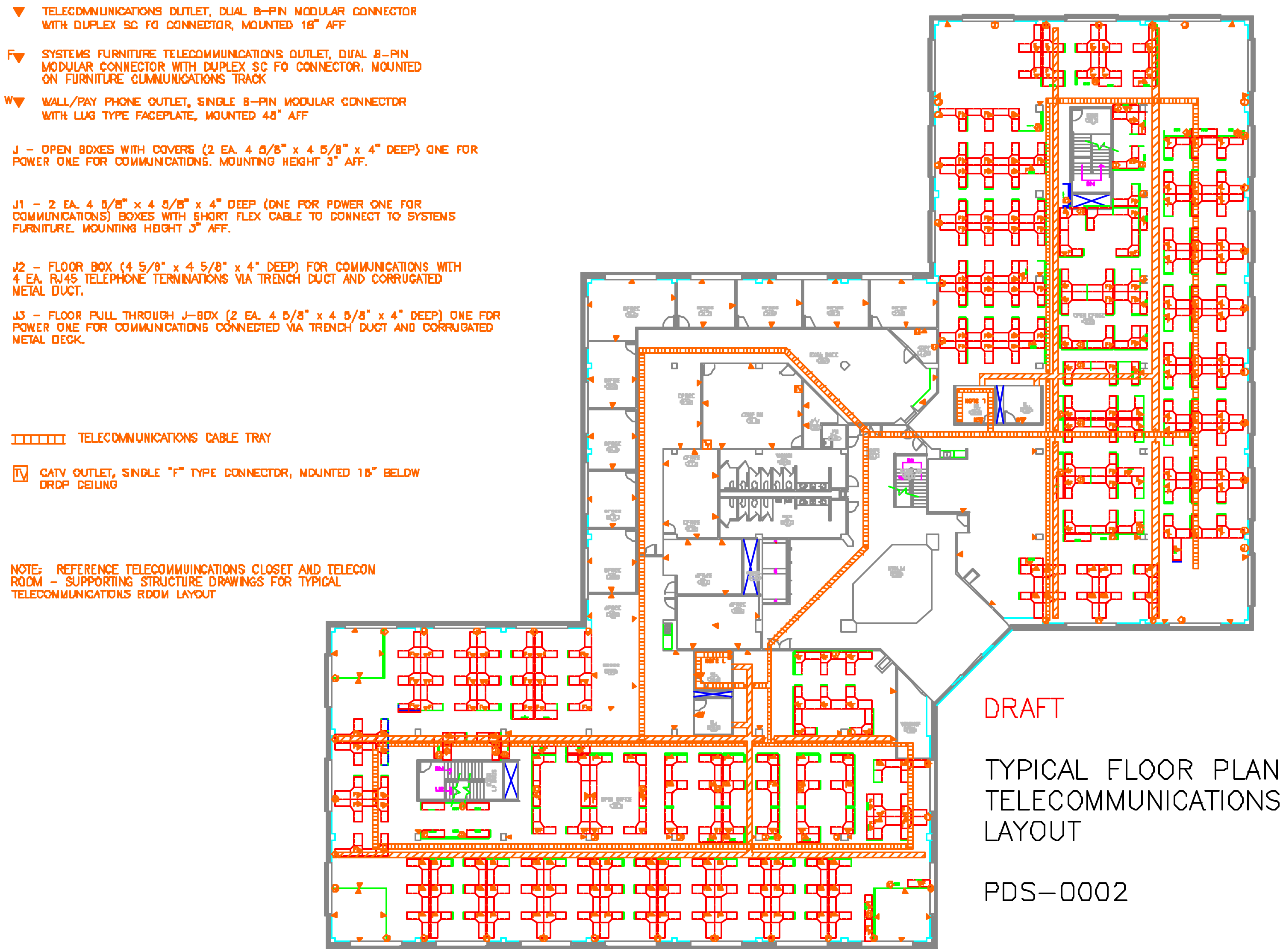



**Figure 2-8: Typical Floor Plan**

# 3 Outside Plant. An overall schematic for outside plant sizing of duct and cable is provided as Figure 3-2: OSP Infrastructure Standards.

## 3.1 Environmental and Historical Considerations.

3.1.1 Most military installations have areas that may be affected by environmental or historical matters. Environmental hazards may include toxic waste, fuel spillage/leakage, asbestos, unexploded ordinances, etc. Wildlife preservation may be another area of concern at some sites. Compliance with historical restrictions will require special engineering considerations (type of exterior facing, mounting of terminals, placement of pedestals, etc.).

3.1.2 Although these issues may not appear to have a high impact on the engineering solution, the price of conformance to site restrictions may add considerable cost to the project. Special conditions shall be discussed with the DOIM and agreements documented.

## 3.2 Construction/Installation Alternatives.

3.2.1 General Installation.

3.2.1.1 Road Crossings. The cable route shall be planned to cross the road as necessary to serve subscribers without the use of aerial inserts, if possible. Such crossings could be constructed by cutting or sawing perpendicularly across the road, by trenching perpendicularly across the road, by directional boring under the road, or by pipe pushing under the road. Since road crossings are often undesirable and expensive, construction route planning personnel shall select the side of the paved road for the most general routing of the cable, which will result in the fewest crossings.

3.2.1.2 Right-of-Ways. Permission shall be obtained from Department of Transportation authorities at locations where public right-of-ways are used. Possible highway improvements, such as road widening, shall be considered in planning the construction route. Future roadwork can result in costly telecommunications plant rearrangements or relocations. Additional lead-time is required to obtain permission for public right-of-ways. Detailed drawings showing proposed route, depths, and other pertinent information are required and shall be furnished to the approving authorities for review far in advance of anticipated installation. Alternate designs shall be explored in case the right-of-way is denied.

3.2.1.3 OSP Cable Placement Options. Underground (manhole and duct) system is the preferred placement option for outside cable plant in new construction and rehabilitation. Direct buried and aerial cable plant systems shall not be used except in cases where underground systems cannot be installed or conformance to local mandates is required.

3.2.2 Underground (Manhole/Duct). Supporting documentation for construction of manhole and duct is found in Rural Utilities Service (RUS) Bulletin 1751F-643/RUS Form 515C (http://www.usda.gov/rus/telephone/regs/1751f643.htm), RUS Bulletin 1751F-644 (http://www.usda.gov/rus/telephone/regs/1751f644.htm), and REA Bulletin 345-151.

3.2.2.1 Manholes. See Figure 3-5: Manhole Typical for additional details.

3.2.2.1.1 Types. Typical manhole size shall be 12 feet (L) x 6 feet (W) x 7 feet (H). Multidirectional manholes shall be used. Splayed manholes would be beneficial (near Main

Communications Node (MCN)/Area Distribution Node (ADN) where large cables are engineered).

3.2.2.1.2 Ovcrsized Manholes. To avoid catastrophic loss of service in case of building destruction, fibers providing physical route diversity shall not be routed through the MCN or ADNs. These cables shall be spliced in the manhole and routed to their ultimate destination without entering the MCN/ADN. The manhole placed outside an MCN/ADN shall be oversized to allow for this additional splicing.

3.2.2.1.3 Basic Layout. Measurements between manholes are from lid to lid (center to center). Measurements from manholes to buildings, to pedestals, riser poles, etc. are from the manhole lid to outside wall, bottom of pole, etc. (center to point). New manholes shall be placed 500 feet apart. However, consideration shall be given to varying this distance to make maximum use of the duct system. For example, if increasing or shortening the distance by 100 feet will allow installation of the ducts to avoid a building or other obstruction in the intended path, then the adjustment shall be made if it does not violate the cable reel lengths for the cables to be installed.

3.2.2.1.4 Accessories. Each new manhole shall be equipped with a sump, pull irons, ground rod, cable racks and hooks. Cable hooks shall be placed to adequately support the weight of the cable and case.

3.2.2.1.4.1 Sump. A sump shall be cast into the floor of the manhole. The floor shall slope toward the sump to provide drainage from all areas into the sump. The sump shall be approximately 13 inches square and 4 inches deep and covered with a removable perforated or punched-steel plate to permit drainage. The cover shall be fastened to the housing by a chain or a hinge.

3.2.2.1.4.2 Pull Irons. Cable pull irons shall be installed on the wall opposite each main conduit entrance location 6 inches to 9 inches from floor of manhole in line with the conduit entrance. The pull irons shall be placed and embedded during the construction of the manhole wall.

3.2.2.1.4.3 Ground Rod. A 5/8-inch by 8-foot galvanized steel ground rod shall be installed in the floor of each manhole placed under each effort. Four inches of the rod, plus or minus 1/2 inch, shall extend above the finished floor level. The rod shall not enter the manhole more than 3 inches nor less than 2 inches out from the vertical surface of the adjacent wall. All manhole splices shall be bonded to the manhole ground. In existing manholes new ground rods and/or bonding ribbon shall be designed at each splice location if none presently exist. Note: Pull throughs require no grounding.

3.2.2.1.4.4 Bonding Ribbon. Bonding ribbon shall be installed in all new manholes. The bonding ribbon shall be attached to all rack anchors and be precast into the manholes.

3.2.2.1.4.5 Hardware. Three cable racks, each containing 36 hook spaces mounted vertically, shall be provided on each long wall. End wall manhole racks shall be provided at the T-end of multi-directional manholes. Corner racks shall be provided at the in-line end of the manhole. Racks shall set out from the wall a minimum of 3 inches. Each cable rack shall be equipped with hooks to support all existing cable or if there are no existing cables, each rack shall be equipped with two cable hooks (minimum length 7 and 1/2 inches). All racks and hooks shall be of galvanized metal or noncorrosive materials.

3.2.2.1.5 Stencil. All new manholes shall be stenciled with a number designated by the DOIM.

3.2.2.2 Handholes. The installation of handholes is not suggested. The cost savings are minimal and do not overcome the limited work space and future problems experienced with handhole installation. The preferred solution is the installation of a full-size manhole. Handholes may be installed if the space is limited or under other extenuating circumstances.

3.2.2.3 Duct.

3.2.2.3.1 Type of Duct. The type of duct for new installation shall be polyvinyl chloride (PVC), Schedule 40. Thin-wall duct may be used in lieu of PVC, Schedule 40 if the duct is concrete encased. Since thin-wall duct is less robust than Schedule 40, care shall be taken to ensure that the thin-wall duct is not damage (cracked or crushed) prior to installation.

3.2.2.3.2 Minimum Duct Sizing. The minimum sizing for new duct is shown on Figure 3-2: OSP Infrastructure Standards. All duct sizes shall be designed to allow for current cable, new cable under this effort, and 25 percent growth. Minimum sizing is listed below.

a) Duct between the cable vault and the first manhole shall be based upon the size of the switch and the number of outside cable pairs served from the switch location.

b) Main duct runs shall be a minimum of 6-way, 4-inch (one of which is subduct).

c) Lateral duct runs shall be a minimum of 4-way, 4-inch (one of which is subduct).

d) Building entrance ducts shall be a minimum of 2-way, 4-inch (one of which is subduct).

3.2.2.3.3 Depth of Cover. At least 24” of cover is required above the top of the duct. Less cover is required under roads or sidewalks (if duct is concrete encased). See Figure 3-4: Conduit Placement and Cut & Resurface for details.

3.2.2.3.4 Trench Width. To install ducts, the trench width depends on the number of ducts, size of ducts, arrangement of ducts, and space around ducts (at least 2”). Additional width may be required to work in deep trenches or with large count duct banks. See Figure 3-4: Conduit Placement and Cut & Resurface for details.

3.2.2.3.5 New Duct Placement. In a new duct run, the duct shall be swept down into the lower duct window. This practice will allow for easier expansion of the duct run in the future.

3.2.2.3.6 Rerouting of Existing Duct. Existing duct shall be joined to new manholes (precast or cast-in-place) by rerouting the designated ducts from the demolished or abandoned manhole to the new. Rerouting shall begin far enough back from the old manhole to allow for standard bending radius and pulling tension. Continuity of operations on the affected cables shall be maintained during the duct rerouting actions.

3.2.2.3.7 Reinforced Duct Placement. Typically, new reinforcing duct is engineered for placement in the manhole below the existing duct appearance; however, per Government guidance, the duct shall be placed above the existing duct bank, if the minimum top cover is provided, or beside the existing duct bank.

3.2.2.3.8 Concrete Encasement. Concrete encased duct or galvanized steel pipe shall be placed under all paved road surfaces and certain heavy-traffic non-surfaced roads. In accordance with the HQDA Minimum Essential Requirements (MER), all ducts within the cantonment area be concrete encased. The contractor shall use only one brand of Portland cement that conforms to RUS Bulletin 1751F-644 (http://www.usda.gov/rus/telephone/regs/1751f644.htm).

3.2.2.3.9 Rock. Excavate rock to a minimum of 4 inches below the trench depths required. Backfill the rock excavation and all excess trench excavation with a 4-inch cushion of sand.

3.2.2.3.10 Unstable Soil. When wet or otherwise unstable soil incapable of properly supporting this conduit is encountered in the trench bottom, remove such soil to the depth required and backfill the trench to trench bottom grade, with coarse sand or fine gravel.

3.2.2.3.11 Bends and Sweeps. Accomplish changes in direction of runs exceeding a total of 10 degrees, either vertically or horizontally, by long sweeping bends having a minimum radius of 25 feet; exception--manufactured bends may be used on subsidiary/lateral conduit at the riser pole or building entrance. Long sweeps may be made up of one or more curved or straight sections and/or combinations thereof. Manufactured bends shall have a minimum radius of 24 inches for all conduits 3 inches in diameter or larger. Conduits shall terminate in bell ends at point of entrance into manhole.

3.2.2.3.12 Pull String/Rope. Pull string shall be installed in each new conduit or innerduct/subduct. A minimum of 5 feet of pull string shall be provided at each end of the conduit. The pull string shall be coiled and secured to the wall.

3.2.2.3.13 Plugs. All ducts, whether main or subsidiary runs, not scheduled for immediate use shall be plugged using acceptable duct plugs or plugging compound.

3.2.2.3.14 Galvanized Steel Pipe (GSP).

3.2.2.3.14.1 For road crossing using the cut and restore method, GSP shall generally only be used if the local DPW or DOIM request that trenches not be left open across roadways for an extended duration (to allow for concrete to harden). Otherwise, concrete encased duct shall be used.

3.2.2.3.14.2 GSP shall be used to push under railroad crossings. See Figure 3-4: Conduit Placement and Cut & Resurface for details on railroad crossing.

3.2.2.3.15 Split Duct. Split Duct is designed for use on a long cable run (normally fiber optic) where the cable is placed in the open duct while the duct and trench are still open. Split Duct shall be used for all road crossings only after 1/5 of the cable reel length for cables greater than 1inch in diameter, and 1/3 of the cable reel length for cables less than 1inch in diameter, is utilized in each unspliced span (up to 5,000'). Normal conduit shall be utilized at all other areas.

3.2.2.3.16 Rod/Mandrel/Slug/Clean Ducts or Conduits.

3.2.2.3.16.1 To rod a duct means to push or pull a device (mandrel) through a duct which cleans it of stones or rubble and prepares it to receive a cable.

3.2.2.3.16.2 A mandrel is a cylindrical object pulled through a duct to prove that the duct is suitable to be used for the installation of cable. The mandrel’s diameter depends on the type and size of the ducts.

3.2.2.3.16.3 Existing vacant ducts shall be mandrelled if planned for use for new cable installation. The ducts are rodded and mandrelled to detect any obstructions, collapsed ducts, or duct inconsistencies.

3.2.2.3.16.4 Do not mandrel the ducts if existing cables are in the duct.

3.2.2.4 Subduct/Innerduct.

3.2.2.4.1 Subduct shall be used when installing new conduit systems. Each subduct shall provide four 1.5” conduits in the space that is normally occupied by a 4” conduit. Each pathway shall be provided with pull string. One out of every 4 new ducts shall be subduct.

3.2.2.4.2 Innerduct is used in existing conduit systems, in GSP or split GSP, or in open trenches for direct buried fiber optic cables. The Government’s preference is to use the rigid type innerduct with pull string instead of the flexible innerduct. The type and size of existing conduit shall determine the number of innerducts. Typically, four 1-inch innerducts are placed in a 4-inch conduit. Although more innerducts will physically fit in a 4-inch duct, the twisting and intertwining of the innerducts make installation infeasible.

3.2.3 Direct Buried. Supporting documentation for buried cable installation is available in RUS Bulletins 1751F-640 (http://www.usda.gov/rus/telephone/regs/1751f640), 641 (http://www.usda.gov/rus/telephone/regs/1751f641), and 642 (http://www.usda.gov/rus/telephone/regs/1751f642).

3.2.3.1 Type of Cable. Rodent protected cable shall be used for buried applications. Typically, all non-rodent proof direct buried cables shall be placed in buried innerduct when the outer diameter of the cable is smaller than a gopher’s bite dimensions.

3.2.3.2 Warning Tape. Buried cable warning tape shall be used for all direct buried applications. The tape shall be installed 12 inches above the cable.

3.2.3.3 Warning Signs. Buried cable warning signs or route markers are required no less than every 250 feet or at each change in route direction, both sides of street crossings, pipelines, and buried power cables.

3.2.3.4 Plow.

3.2.3.4.1 A cable laying plow cuts a slot as it is pulled forward. The cable is fed in and pushed to the bottom of the slot and the slot closes on it as the machine proceeds forward.

3.2.3.4.2 Plowing shall be used in range environments where there are no significant obstacles and cable runs typically exceed 1000 feet between splices.

3.2.3.5 Trench.

3.2.3.5.1 Trenching involves the excavation of a ditch to place the cable.

3.2.3.5.2 To direct bury a cable, a 6-inch trench width is normally adequate.

3.2.3.5.3 Hand dig at all existing manhole locations, building entrance points, utility crossings, through tree roots, under curbs, etc.

3.2.3.6 Cut/Resurface vs. Push/Bore. See Figure 3-4: Conduit Placement and Cut & Resurface for placement details.

3.2.3.6.1 Directional boring in buried plant construction shall be considered as an alternative method of installing cables or wires under highways, streets, driveways, across lawns, etc., to avoid repairing and restoring these items to their pre-construction appearances.

3.2.3.6.2 When measuring for road crossings where a push and bore may be the installation method used, ensure that there is space for the installer to place his pushing equipment and receive trench. Prior coordination shall be made with the DPW to determine which roads or other surfaces cannot be cut.

3.2.3.6.3 Push and bore method shall be used for railroad crossings. For railroad crossings 16-inch steel casings shall be used and the pipe shall extend no less than 6 feet beyond each outside rail or rail bed, whichever is greater, and shall be located no less than 42 inches below the base of the rails.

3.2.3.6.4 Pushes and bores shall not be engineered for sites with rocky soil conditions. Cut and resurface methods shall be utilized.

3.2.3.7 Depth of Placement.

3.2.3.7.1 According to RUS Bulletin 345-150/RUS Form 515A, the minimum depth of placement for a direct buried cable shall provide cover of 24 inches in soil, 36 inches at ditch crossings and 6 inches in solid rock.

3.2.3.7.2 To direct bury a fiber optic cable the minimum depth shall provide cover of 40 inches. In solid rock, the minimum depth is reduced to 6".

3.2.3.7.3 The DOIM may have special depth requirements for certain areas (i.e., tank tracks, ranges, etc.).

3.2.3.8 Buried Splicing.

3.2.3.8.1 Buried splices shall only be engineered if any of the following conditions apply: Electrical or Explosion Hazard (i.e., ammunition areas), Vehicular Hazard (i.e., motor pool areas), or Security Hazard (i.e., within a high security compound).

3.2.3.8.2 All other splices in a direct buried run shall be placed in pedestals or handholes and shall be encapsulated.

3.2.4 Aerial. Supporting documentation for aerial placement is available in RUS Bulletin 1751F-630 (http://www.usda.gov/rus/telephone/regs/1751f630) and REA TE&CM 635.

3.2.4.1 Aerial Installation Guidance. Aerial installations shall only be used in extenuating circumstances or long runs outside of the cantonment area. Small segments of aerial cable (known as "aerial inserts) may be necessary for sections of a buried cable run. The aerial inserts may span ravines, creeks or rivers, or rocky areas.

3.2.4.2 Messenger Strand.

3.2.4.2.1 A 2.2M strand shall only be used as a replacement or extension of existing 2.2M strand. 6M strand shall be the smallest size strand utilized for new cable(s).

3.2.4.2.2 Fiber optic cable shall be installed on its own messenger. Copper and fiber cables shall not be lashed on the same messenger.

3.2.4.2.3 Figure-8 cable may be installed; however, no additional cable shall be lashed to it.

3.2.4.3 Guys and Anchors. Place new guys and/or anchors for each new messenger strand at each applicable location (cable turns, wind loading, cable ends, etc.). The down guy shall be sized to the next larger strand.

3.2.4.4 Aerial Splices.

3.2.4.4.1 Aerial fiber splices shall be minimized. If possible, splice the fiber optics in a pedestal at the bottom of the pole.

3.2.4.4.2 Support all terminals and splices either by attachment to the messenger cable or direct attachment to a fixed object (pole, building, pedestals, etc.). Devices shall not be supported by the cable.

3.2.4.4.3 Aerial Terminals.

3.2.4.4.4 Pole-mounted terminals are preferred over strand-mounted terminals.

3.2.4.4.5 Fixed-count terminals are preferred over ready-access (random-count) terminals.

3.2.4.4.6 Terminals shall be placed so that no single drop exceeds 500 feet in length.

3.2.4.5 Horizontal Clearances for Poles/Aerial Cable. These and additional horizontal clearances can be found in the AT&T Outside Plant Engineering Handbook (Handbook may be ordered at http://www.lucent8.com/cgi-bin/CIC_store.cgi, Document Number AT&T 900-200-318).

a) Fire hydrants, signal pedestals – 4 feet
b) Curbs – 6 inches
c) Railroad tracks – 15 feet
d) Power cables under 750 V – 5 feet or more

3.2.4.6 Vertical Clearances for Aerial Cable. These and additional vertical clearances can be found in the AT&T Outside Plant Engineering Handbook (Handbook may be ordered at http://www.lucent8.com/cgi-bin/CIC_store.cgi, Document Number AT&T 900-200-318).

a) Streets or roads – 18 feet
b) Driveways to residences and garages – 10 feet
c) Alleyways – 17 feet
d) Pedestrian walkways – 8 feet
e) Railroad tracks; measured from top of rail – 27 feet

3.3 General Cable Specifications.

3.3.1 Cable Distances.

3.3.1.1 Underground. Measurements between manholes are from lid to lid (center to center). Measurements from manholes to buildings, to pedestals, riser poles, etc. are from the manhole lid to outside wall, bottom of pole, etc. (center to point).

3.3.1.2 Buried. Measurements for direct buried shall be point to point.

3.3.1.3 Aerial. Measurements for aerial cable shall be taken so that the cable could be direct buried. Measure from pole to pole and from pole to building attachments or entrance terminal etc. Do not forget to account for sag in the aerial measurements.

3.3.2 Bending Radius. The minimum bending radius for copper cables and wires shall not be less than 10 times the outside diameter of the copper cable or wire. The minimum bending radius for fiber optic cables shall not be less than 20 times the outside diameter of the fiber optic cable. If cables or wires are bent too sharply, damage could occur to the copper conductors, optical fibers, shields, armors, and/or jackets of the cables or wires.

3.3.3 Cable Identification.

3.3.3.1 Cable Tags. Cable tags shall be installed at all termination points (terminals) and splices, including house cables. In manholes, cables shall be tagged between the splice and the end wall and on both sides of a splice loop or maintenance loop. Only one tag is required for a copper cable pull-through and two tags for a fiber optic cable pull through.

3.3.3.2 To identify a copper cable you need both: SIZE + TYPE <u>and</u> CABLE ID + COUNT.

3.3.3.3 Cable sizes shall be identified with an abbreviation. For example, a 1200-pair cable will be identified as P12-24PF. All cables with less that 25 pairs will include an "X."

| | | |
|---|---|---|
| 6 pair | = | P6X-24PF |
| 12 pair | = | P12X-24PF |
| 18 pair | = | P18X-24PF |

3.3.3.4 To identify a 900 pair, 24 AWG copper cable:

| | | |
|---|---|---|
| P9-24PF | = | Size and Type |
| 03, 1-900 | = | Cable # and Count |

(Only <u>existing</u> cable is identified with a 'CA' prefix.)

3.3.3.5 To identify two different cables under the same sheath:

P21-24PF
07, 1-1500+T1, 1-400+200 DD

3.3.3.6 Fiber Optic Cables shall be identified with CABLE ID + COUNT and then SIZE + TYPE.

| | | |
|---|---|---|
| FOC 12, 1-72 | = | Cable # and Strand Count |
| 72G10F | = | Type of Cable |

3.3.4 Copper.

3.3.4.1 Copper Cable (Cut) Length. To calculate the cut length of copper cable consider the following:

a) Determine the point to point (PP) distance by adding together the center to center (CC) distances between splice points.

b) Add 10 feet for every manhole pulled through for racking. Consider it as 5 feet extra on the cable as it comes in and 5 feet extra on the cable as it goes out.

c) For manholes with splices in them, add 20 feet to each end of the copper cable for splice length (total 40').

d) For pedestal splices add 20 feet to each cable end.

e) For cables terminating in buildings, allow for the elevation change from the trench to the PET, cable route in the building and 20 feet for the termination. If the PET is more than 50 feet inside the building, the outside plant cable shall be placed in EMT.

3.3.4.2 Copper Reel Lengths. A list of standard copper reel lengths is listed in Figure 3-1: Standard Cable Reel Lengths and Diameters. Be aware that each manufacturer may differ slightly from these numbers.

3.3.4.3 Splices.

3.3.4.3.1 For splicing cables over 25 pairs, 25-pair splice modules shall be used.

3.3.4.3.2 Binder group integrity shall be maintained. Split binders (of 25-pair groups) shall not be spliced through any splice or taper point.

3.3.4.3.3 All dead pairs in a copper cable shall be spliced through if the size of the continuing cable will allow a clear and cap at the other end. This method will provide a continuous path for the total distance of the dead pairs in case the path is needed in the future.

3.3.4.3.4 All underground and buried splice cases shall be filled with encapsulant upon completion of the splice in accordance with REA Bulletin 345-72 (PE-74). Bond cable sheaths at all cable splices with bonding harnesses to assure sheath continuity.

3.3.4.4 Cable Count Assignment.

3.3.4.4.1 When assigning cable counts, the center of the cable shall be the last pairs assigned on a cable route. The upper or higher cable pair counts shall be used first. Therefore, the highest pair count in a cable shall be located closest to the switch location and the lowest pair count shall be farthest away.

3.3.4.4.2 Per the requirements of 6- and/or 12-pair terminals, pair 13 (of a binder group) rather than pair 1 is to be spared.

3.3.4.5 Cable Gauge, Resistance Design.

3.3.4.5.1 The preferred cable gauge is 24 AWG; however, 26 AWG may be used in high-density areas and 19 AWG may be required on longer runs (such as ranges).

3.3.4.5.2 To increase the signaling limit distance, start with the small gauge (large AWG number) at the dial central office and work out and up to a larger gauge (smaller AWG number), i.e., AWG 26 to AWG 24 to AWG 22 (not AWG 22 to AWG 26). Mixing gauges shall be engineered in accordance with resistance charts and tables in RUS TE&CM 424 and 426.

3.3.4.6 Loading.

3.3.4.6.1 Analog sets/circuits shall be loaded when subscriber loops extend beyond 18,000 feet.

3.3.4.6.2 When loading is required, H88 loading shall be utilized: 3,000 feet from the DCO for the first load (must include calculations for tip cables, jumper wire, etc.), then every 6,000 sheath feet thereafter. End sections must be greater than 3,000 feet and less than 12,000 feet. End sections include all drops and station wire.

3.3.4.6.3 If required, build-out capacitors shall be designed for placement between load points. The build-out capacitors insert additional capacitance to compensate for distances shorter than 6000 feet between loads or between loads and end sections.

3.3.4.6.4 Pairs for any data circuit shall NOT be loaded.

3.3.4.6.5 If digital or data sets (no analog) are to be used for the telephone system, NO pairs shall be loaded. The user may have to provide loop extenders for long loops or the design shall include pair gain devices.

3.3.5 Fiber.

3.3.5.1 Type. All outside plant fiber cable shall be single-mode. Multimode fiber may be installed only in situations involving the extension of existing systems that cannot be adapted to single-mode cable.

3.3.5.2 Fiber Cable Cut Length. To calculate the cut length of FOC consider the following:

a) The sum of the PP and/or the CC distances between splices.

b) All FOC pulled through manhole shall include a 20-foot maintenance loop in addition to the 10-foot racking length.

c) In accordance with FM 11-487-5, paragraph 3-3.d, for a fiber splice in a manhole: "Assure that enough slack is pulled from both ends to have enough cable for racking and to pull 30 feet or whatever length it takes to get past the top of the manhole to the splicing trailer from each direction."

d) Add 10 feet to each cable end for aerial splicing ends.

e) Add 65 feet to each cable end for direct buried splicing (55' for the splice pit loop + 10' splice end).

f) Add 20 feet for the splice end at an equipment rack location (the approximate height {2x} and width of the equipment rack).

3.3.5.3 Fiber Reel Lengths. Fiber optic cables are available on up to 40,000-foot reels regardless of the number of strands. Small strand sizes may increase reel lengths. Actual reel lengths shall be obtained from the manufacturer.

3.3.5.4 Fiber Cable Count Assignment. FOC strand counts shall be assigned in a similar manner as copper counts. The high number counts shall be dropped off first and strand one count shall be the farthest from the DCO.

3.3.5.5 Use of Innerduct/Subduct. For underground installation, each fiber optic cable shall be installed in innerduct or subduct. If no innerducts are available, the installation of innerduct in the 4" conduit shall be included. Fiber optic cable shall not be installed directly in a 4" duct.

3.3.5.6 Splices and Power Budget.

3.3.5.6.1 In accordance with RUS Bulletin 1751F-642 (http://www.usda.gov/rus/telephone/regs/1751f642), for buried fiber optic cable plant, direct buried filled splice cases installed in handholes are preferred over burying the splice.

3.3.5.6.2 Every effort shall be made to utilize "loop through" splicing in lieu of homeruns/dedicated cables to the serving location. In "loop through" splicing, only the fiber strands breaking off from the main cable are cut and spliced. The other fibers are not cut. The sheath is cut from the cable, the exiting fibers cut and spliced, and the remaining fibers are simply folded back within the case (not cut) and then routed on.

3.3.5.6.3 Transmission Limitations. The power budget shall be calculated for the fiber optic cable run. If the loss is too great for a standard laser, a long-range laser shall be considered.

3.4 Sizing Requirements.

3.4.1 Copper.

3.4.1.1 The number of outside plant copper pairs is calculated by multiplying the number of users or jumpers in the building times two pairs. This factor will add in some additional pairs for faxes, modems, and special circuits. The cable is then sized to the nearest logical standard cable size.

3.4.1.2 For example, a building with 85 users would require a 200-pair cable (85 x 2 = 170 ==> 200 pair).

3.4.2 Fiber.

3.4.2.1 MCN to Alternate Main Communications Node (A-MCN). The number of fiber strands between the MCN and the A-MCN is dependent upon the number of ADNs. For planning purposes, use 48 strands plus 12 times the number of ADNs. This number of strands will allow for a partial mesh between the ADNs and MCNs. In accordance with Paragraph 3.2.2.1.2, splices for physical route diversity and connection to adjacent ADNs shall be done in the manhole outside the MCN/ADN. Only strands destined for that MCN/ADN shall be routed into the building.

3.4.2.2 MCN to ADN. A minimum of 24 strands of single-mode FOC shall be installed between the ADN/MCNs.

3.4.2.3 ADN to EUB. A minimum of 12 strands of fiber shall be installed to connect the ADNs to the EUBs. If multiple edge devices are required in an EUB, a minimum of 24 strands of fiber shall be installed.

| | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 6X | 19 | 5000 | 0.53 |
| PE-22 | 12X | 19 | 5000 | 0.6 |
| Air Core | 25 | 19 | 5000 | 0.81 |
| Alpeth | 50 | 19 | 2500 | 1.08 |
| Sheath | 6X | 22 | 5000 | 0.43 |
| | 12X | 22 | 5000 | 0.53 |
| | 25 | 22 | 5000 | 0.7 |
| | 50 | 22 | 5000 | 0.85 |
| | 100 | 22 | 5000 | 1.07 |
| | 200 | 22 | 5000 | 1.48 |
| | 300 | 22 | 2000 | 1.75 |
| | 400 | 22 | 2000 | 1.96 |
| | 600 | 22 | 1000 | 2.44 |
| | 900 | 22 | 1000 | 2.88 |
| | 1200 | 22 | 750 | 3.29 |
| | 6X | 24 | 10000 | 0.41 |
| | 12X | 24 | 10000 | 0.46 |
| | 25 | 24 | 10000 | 0.55 |
| | 50 | 24 | 5000 | 0.66 |
| | 100 | 24 | 5000 | 0.87 |
| | 200 | 24 | 5000 | 1.18 |
| | 300 | 24 | 2500 | 1.38 |
| | 400 | 24 | 2500 | 1.53 |
| | 600 | 24 | 2500 | 1.85 |
| | 900 | 24 | 1500 | 2.31 |
| | 1200 | 24 | 1000 | 2.69 |
| | 1500 | 24 | 1000 | 2.92 |
| | 1800 | 24 | 750 | 3.01 |
| | 2100 | 24 | 500 | 3.39 |

| | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 25 | 26 | 10000 | 0.49 |
| | 50 | 26 | 10000 | 0.57 |
| | 100 | 26 | 10000 | 0.71 |
| | 200 | 26 | 5000 | 0.97 |
| | 300 | 26 | 5000 | 1.14 |
| | 400 | 26 | 5000 | 1.30 |
| | 600 | 26 | 2500 | 1.54 |
| | 900 | 26 | 2500 | 1.88 |
| | 1200 | 26 | 1500 | 2.10 |
| | 1500 | 26 | 1500 | 2.32 |
| | 1800 | 26 | 1000 | 2.48 |
| | 2100 | 26 | 1000 | 2.68 |
| | 2400 | 26 | 1000 | 2.90 |
| | 2700 | 26 | 1000 | 3.03 |
| | 3000 | 26 | 750 | 3.20 |

| | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 6X | 22 | 9930 | 0.96 |
| Figure-8 | 12X | 22 | 9930 | 1 |
| Filled | 25 | 22 | 9810 | 1.16 |
| Self-Supported | 50 | 22 | 6540 | 1.34 |
| Alpeth | 6X | 24 | 11340 | 0.88 |
| Sheath | 12X | 24 | 11340 | 0.96 |
| | 25 | 24 | 11340 | 1.02 |
| | 50 | 24 | 11340 | 1.18 |
| | 50 | 26 | 13320 | 1.08 |
| | 100 | 26 | 8820 | 1.26 |

**Figure 3-1: Standard Cable Reel Lengths and Diameters**

| | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 6X | 19 | 5000 | 0.52 |
| PE-89 | 12X | 19 | 5000 | 0.62 |
| Filled | 25 | 19 | 5000 | 0.86 |
| Alpeth | 50 | 19 | 5000 | 1.12 |
| Sheath | 100 | 19 | 2500 | 1.51 |
| | 200 | 19 | 1500 | 2.04 |
| | 6X | 22 | 5000 | 0.48 |
| | 12X | 22 | 5000 | 0.52 |
| | 25 | 22 | 5000 | 0.66 |
| | 50 | 22 | 5000 | 0.86 |
| | 75 | 22 | 5000 | 0.96 |
| | 100 | 22 | 5000 | 1.1 |
| | 150 | 22 | 5000 | 1.32 |
| | 200 | 22 | 2500 | 1.49 |
| | 300 | 22 | 2000 | 1.72 |
| | 400 | 22 | 2000 | 1.96 |
| | 600 | 22 | 1000 | 2.4 |
| | 900 | 22 | 1000 | 2.9 |
| | 1200 | 22 | 750 | 3.28 |
| | 6X | 24 | 10000 | 0.44 |
| | 12X | 24 | 10000 | 0.48 |
| | 25 | 24 | 10000 | 0.58 |
| | 50 | 24 | 10000 | 0.7 |
| | 75 | 24 | 5000 | 0.86 |
| | 100 | 24 | 5000 | 0.94 |
| | 150 | 24 | 5000 | 1.06 |
| | 200 | 24 | 5000 | 1.2 |
| | 300 | 24 | 2500 | 1.45 |

| | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 400 | 24 | 2000 | 1.59 |
| | 600 | 24 | 2000 | 1.92 |
| | 900 | 24 | 1000 | 2.32 |
| | 1200 | 24 | 1000 | 2.68 |
| | 1500 | 24 | 1000 | 2.92 |
| | 1800 | 24 | 750 | 3.2 |
| | 2100 | 24 | 600 | 3.44 |
| | 25 | 26 | 10000 | 0.52 |
| | 50 | 26 | 10000 | 0.58 |
| | 100 | 26 | 10000 | 0.78 |
| | 200 | 26 | 5000 | 1.02 |
| | 300 | 26 | 5000 | 1.18 |
| | 400 | 26 | 5000 | 1.33 |
| | 600 | 26 | 2500 | 1.59 |
| | 900 | 26 | 2000 | 1.92 |
| | 1200 | 26 | 1500 | 2.1 |
| | 1500 | 26 | 1000 | 2.34 |
| | 1800 | 26 | 1000 | 2.6 |
| | 2100 | 26 | 1000 | 2.78 |
| | 2400 | 26 | 1000 | 2.92 |
| | 2700 | 26 | 750 | 3.14 |
| | 3000 | 26 | 750 | 3.24 |

**Figure 3-1 (cont.): Standard Cable Reel Lengths and Diameters**

| | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 6X | 19 | 5000 | 0.58 |
| PE-89 | 12X | 19 | 5000 | 0.66 |
| Filled | 25 | 19 | 5000 | 0.9 |
| Rodent | 50 | 19 | 2500 | 1.18 |
| Protected | 6X | 22 | 5000 | 0.54 |
| Alpeth | 12X | 22 | 5000 | 0.58 |
| Sheath | 25 | 22 | 5000 | 0.7 |
| | 50 | 22 | 5000 | 0.9 |
| | 100 | 22 | 5000 | 1.14 |
| | 200 | 22 | 2500 | 1.51 |
| | 300 | 22 | 2000 | 1.76 |
| | 400 | 22 | 2000 | 2 |
| | 600 | 22 | 1000 | 2.46 |
| | 900 | 22 | 1000 | 2.94 |
| | 1200 | 22 | 750 | 3.28 |
| | 6X | 24 | 10000 | 0.5 |
| | 12X | 24 | 10000 | 0.54 |
| | 25 | 24 | 10000 | 0.58 |
| | 50 | 24 | 10000 | 0.74 |
| | 100 | 24 | 5000 | 0.98 |
| | 200 | 24 | 5000 | 1.26 |

| | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 300 | 24 | 2500 | 1.49 |
| | 400 | 24 | 2000 | 1.63 |
| | 600 | 24 | 2000 | 1.96 |
| | 900 | 24 | 1000 | 2.36 |
| | 1200 | 24 | 1000 | 2.68 |
| | 1500 | 24 | 1000 | 2.94 |
| | 1800 | 24 | 750 | 3.22 |
| | 25 | 26 | 10000 | 0.58 |
| | 50 | 26 | 10000 | 0.66 |
| | 100 | 26 | 10000 | 0.82 |
| | 200 | 26 | 5000 | 1.08 |
| | 300 | 26 | 5000 | 1.22 |
| | 400 | 26 | 5000 | 1.38 |
| | 600 | 26 | 2500 | 1.63 |
| | 900 | 26 | 2000 | 1.92 |
| | 1200 | 26 | 1500 | 2.11 |
| | 1500 | 26 | 1000 | 2.36 |
| | 1800 | 26 | 1000 | 2.62 |
| | 2100 | 26 | 1000 | 2.78 |
| | 2400 | 26 | 1000 | 2.94 |
| | 2700 | 26 | 750 | 3.18 |
| | 3000 | 26 | 750 | 3.26 |

**Figure 3-1 (cont.): Standard Cable Reel Lengths and Diameters**

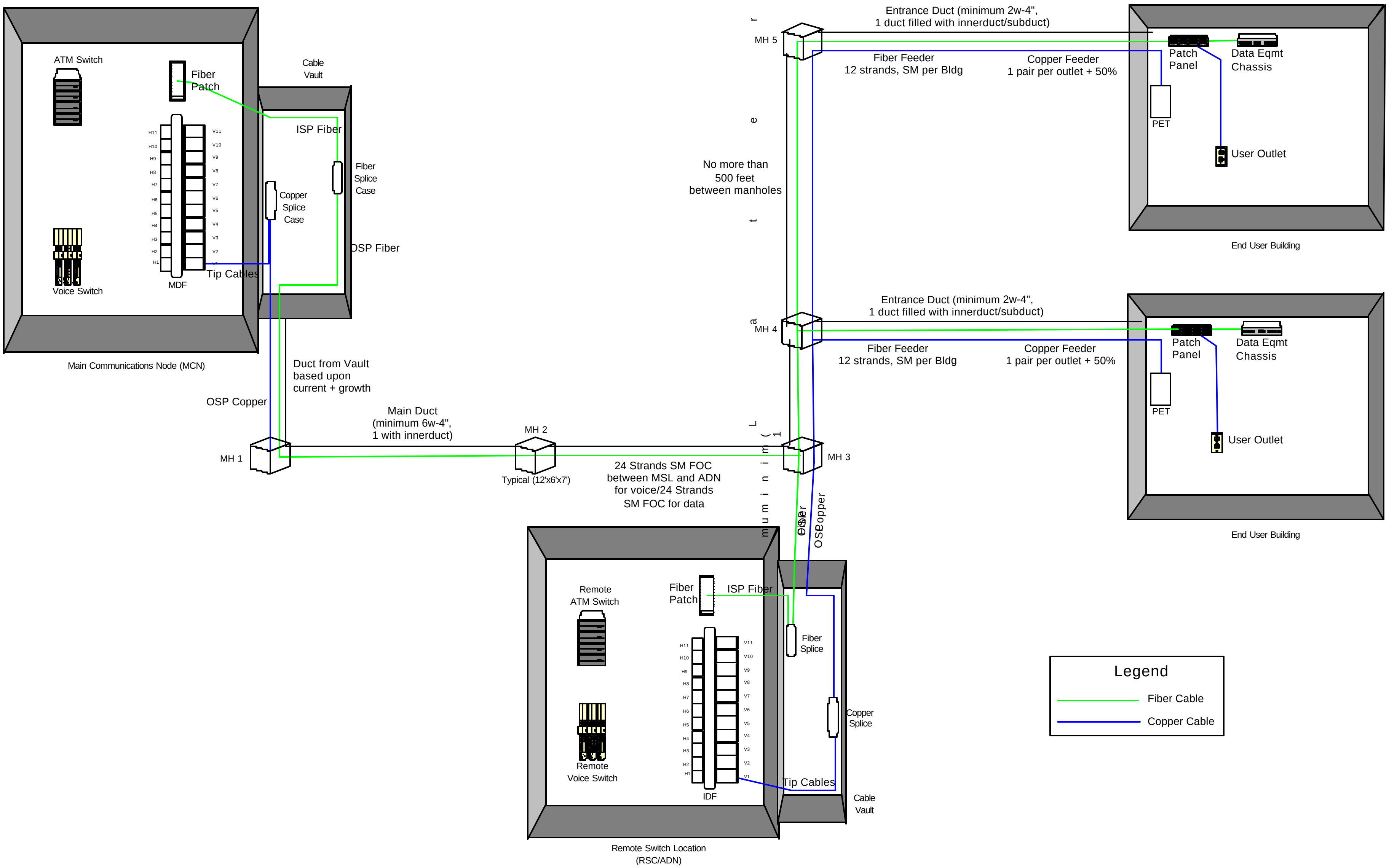



**Figure 3-2: OSP Infrastructure Standards**

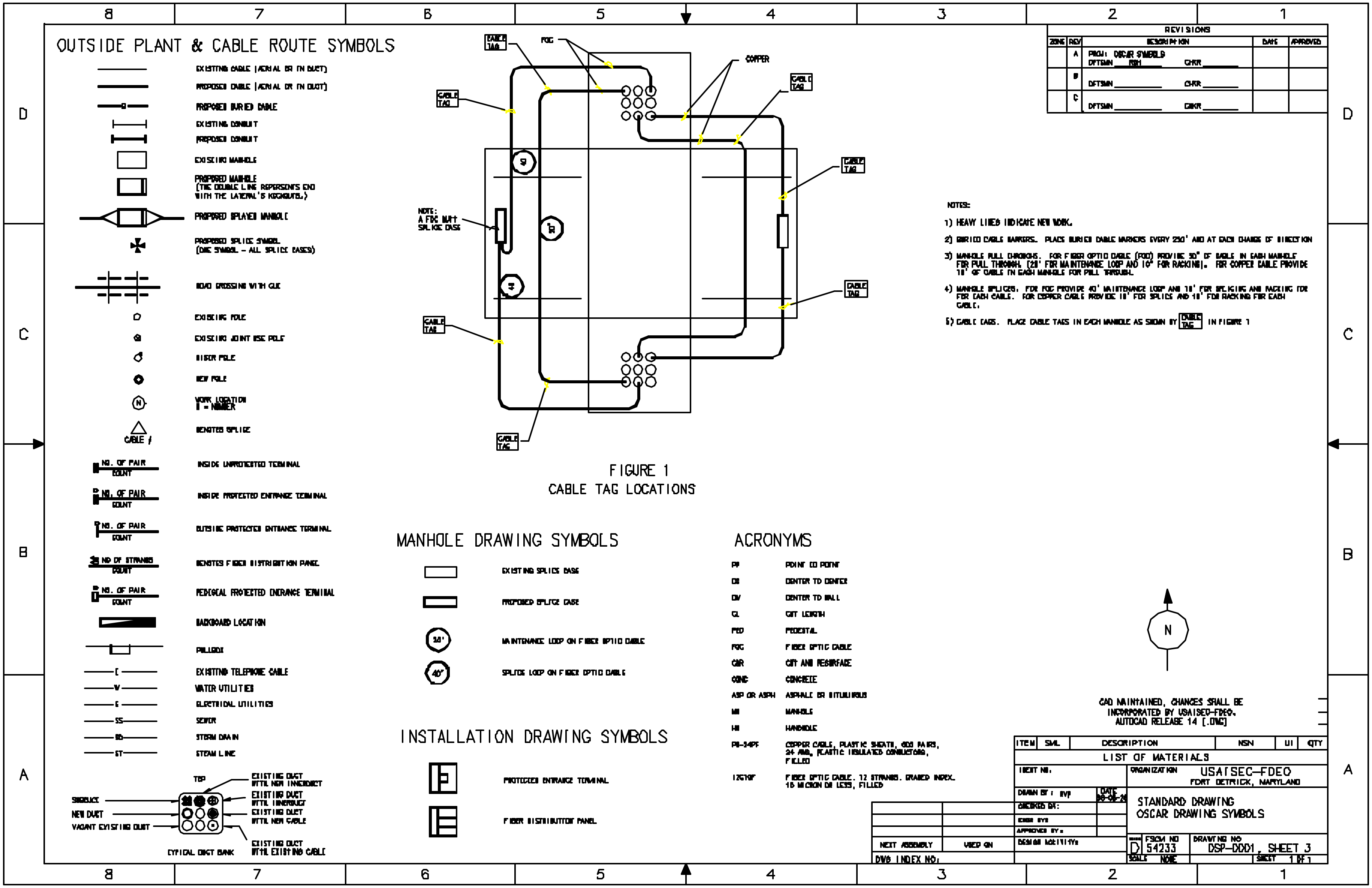


**Figure 3-3: Drawing Symbols**

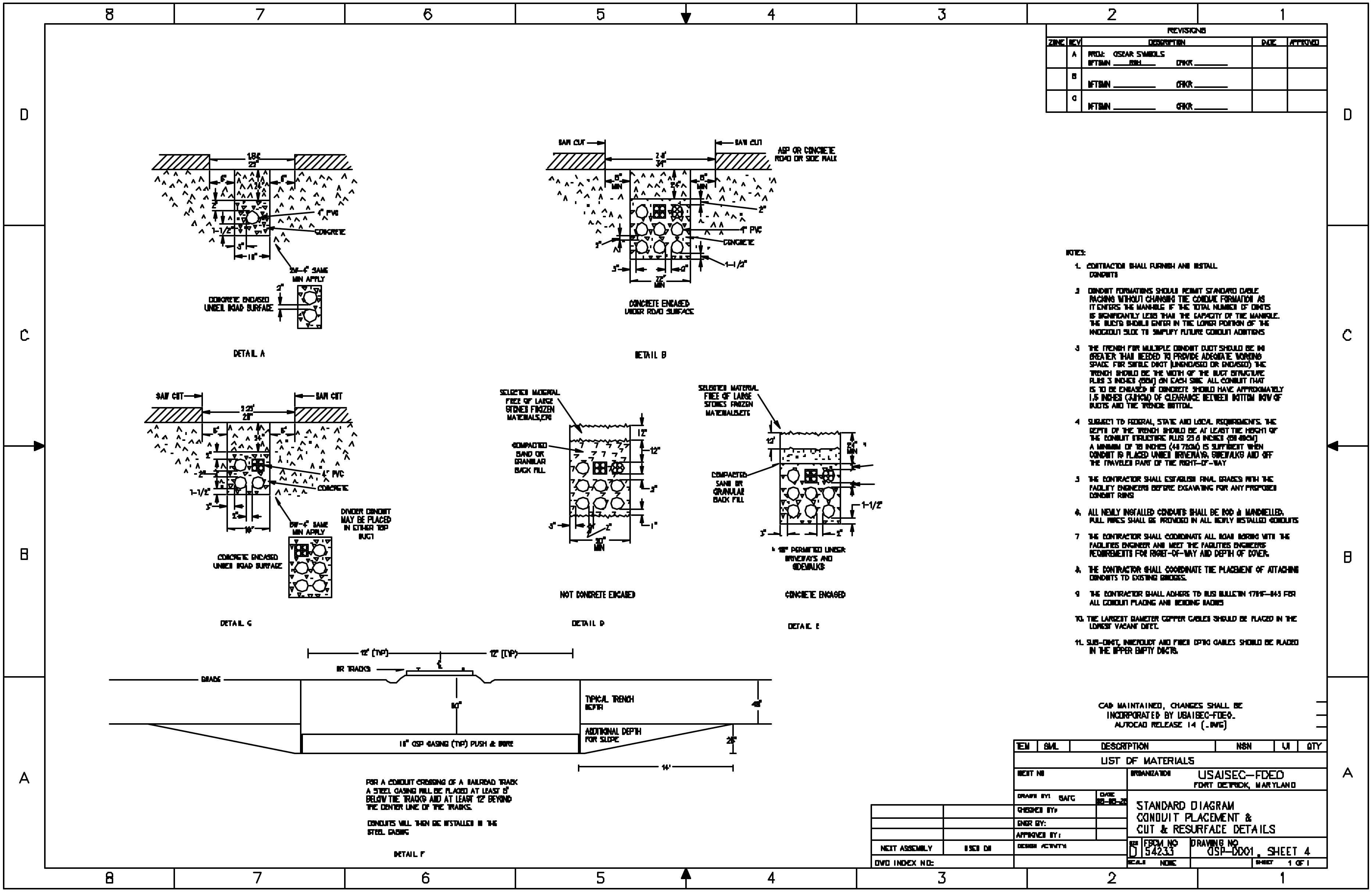



**Figure 3-4: Conduit Placement and Cut & Resurface**

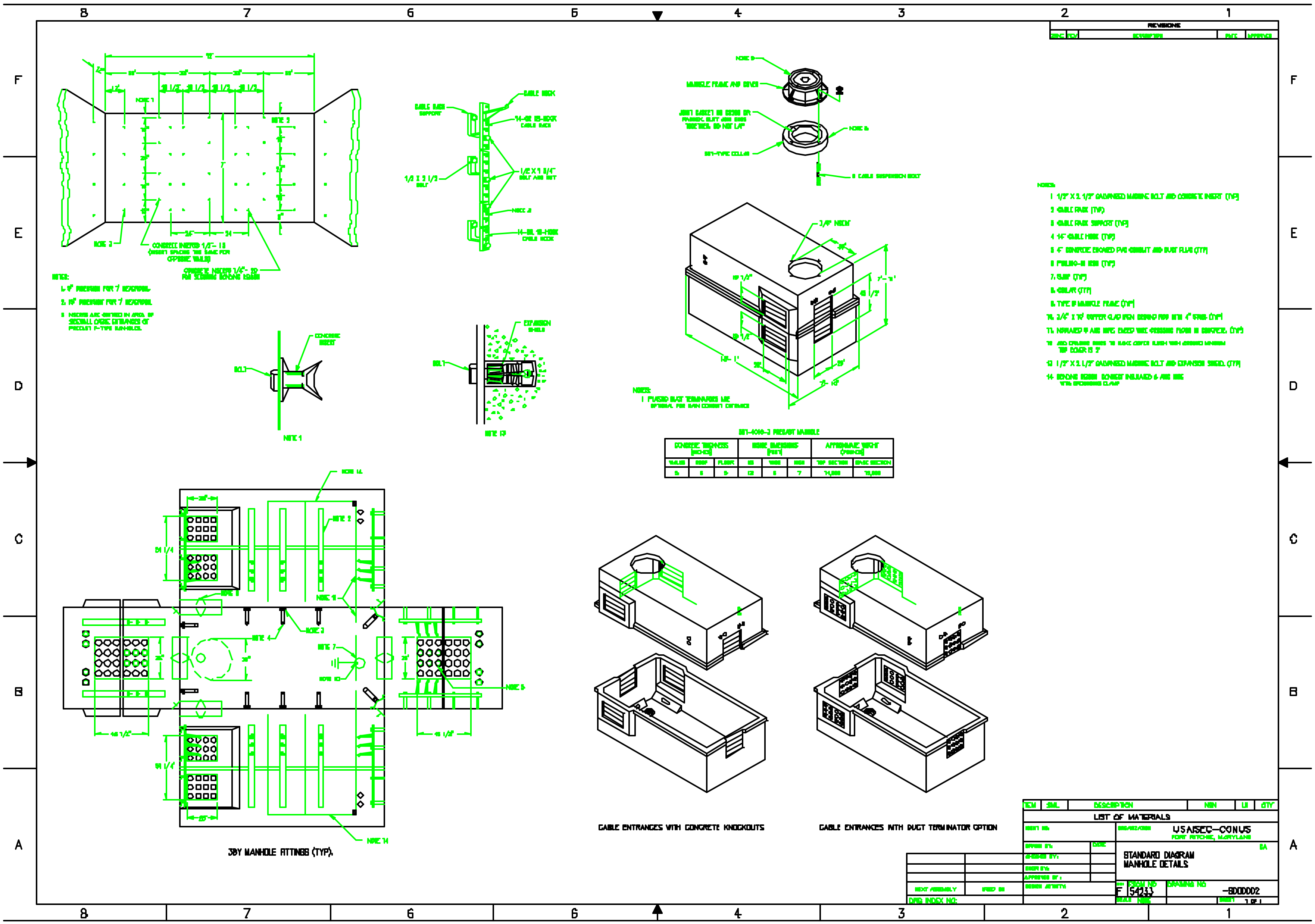



**Figure 3-5: Manhole Typical**

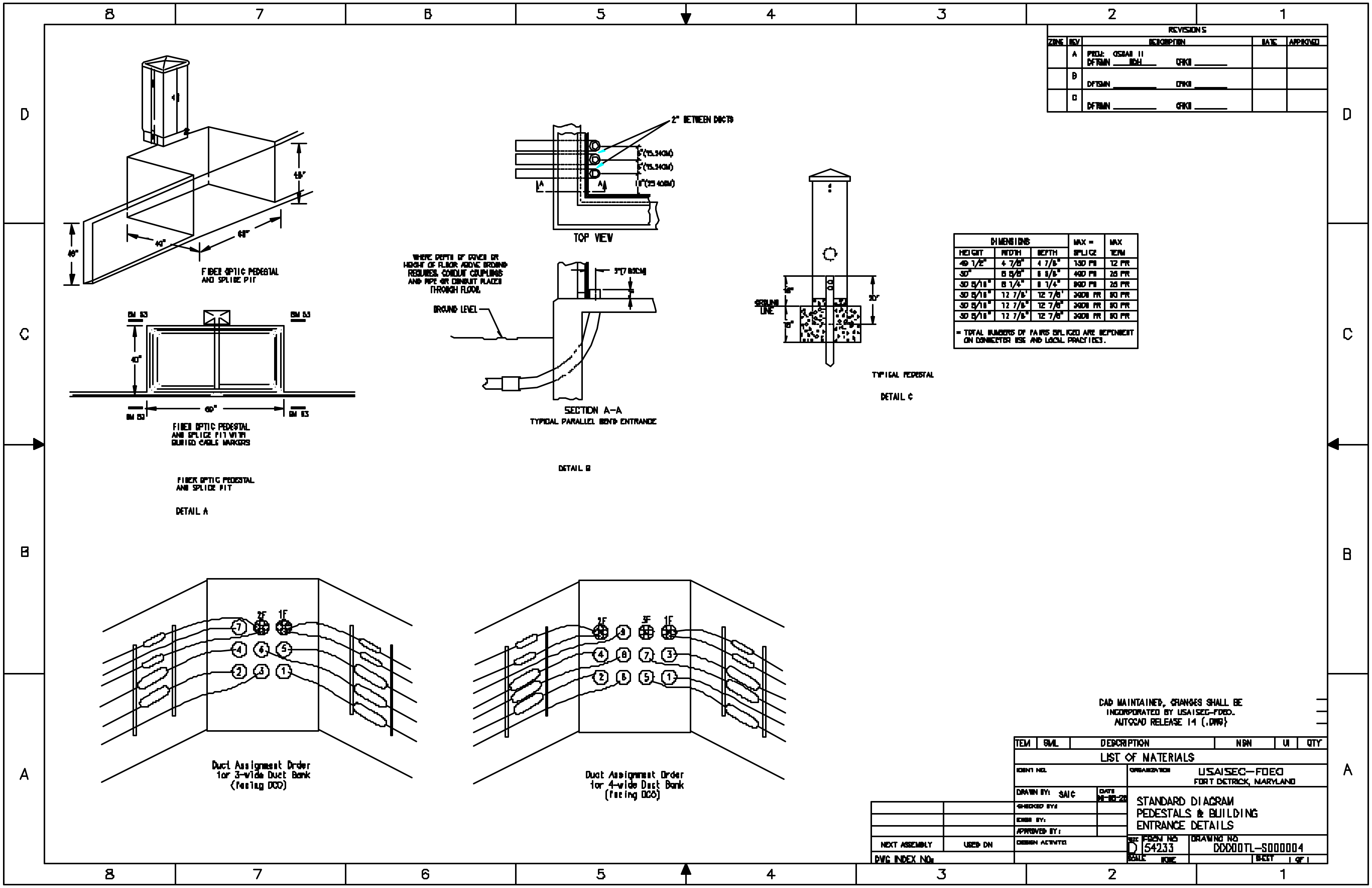



**Figure 3-6: Pedestals and Building Entrance Details**

# 4 Dial Central Office (DCO)/Remote Switching Unit (RSU).

4.1 Most of the information in this section was imported from Automated Information System (AIS) Design Guidance, Telephone Systems developed by USAISEC-CONUS, March 1997 (http://www.isec-sig.army.mil/tg/interface/frame.htm).

4.2 Switch Location and Layout. An example of a switch room is included in Figure 4-2: Typical Switch Room Layout.

4.3 Site Preparation Design Parameters.

4.3.1 The following section lists generic floor space, power, heating, ventilation, and air-conditioning parameters that can be used when planning system installations. The manufacturer's specifications shall be followed for the exact model of equipment actually being installed. The tables are based on the expansion size of the switch.

DCO Floor Space and Heat Loads.

| DCO Air Conditioning Calculations: | | | | | | | |
|---|---|---|---|---|---|---|---|
| DCO SIZE (Lines) | Room Size Square ft | Switch BTU/hr | Ambient BTU/hr | Lights BTU/hr | Total BTU/hr | Convert to Tons Tons/12,000BTU | Required Tons |
| 1920 to 2880 | 600 | 54,608 | 15,000 | 6,145 | 75,753 | 6.3 | 7.5 |
| 2880 to 3840 | 800 | 72,810 | 20,000 | 8,191 | 101,002 | 8.4 | 10 |
| 3840 to 4800 | 1,000 | 91,013 | 25,000 | 10,239 | 126,252 | 10.5 | 12 |
| 4800 to 5760 | 1,500 | 109,216 | 37,500 | 15,360 | 162,076 | 13.5 | 15 |
| 5760 to 6720 | 1,750 | 127,420 | 43,750 | 17,918 | 189,088 | 15.75 | 20 |
| 6720 to 7680 | 1,750 | 145,621 | 43,750 | 17,918 | 207,289 | 17.3 | 20 |
| 7680 to 8640 | 1,750 | 163,824 | 50,000 | 20,478 | 234,302 | 19.5 | 20 |
| 8640 to 9600 | 2,000 | 182,026 | 50,000 | 20,478 | 252,504 | 21 | 24 |
| 9600 to 10,560 | 2,000 | 200,229 | 50,000 | 20,478 | 270,707 | 22.5 | 24 |
| 10,560 to 11,520 | 2,500 | 218,432 | 62,500 | 25,600 | 306,532 | 25.5 | 30 |
| 11,520 to 12,480 | 2,500 | 236,635 | 62,500 | 25,600 | 324,735 | 27 | 30 |
| 12,480 to 13,440 | 2,500 | 254,837 | 62,500 | 25,600 | 342,937 | 28.5 | 30 |
| 13,440 to 14,400 | 2,750 | 273,040 | 68,750 | 28,157 | 369,947 | 30.8 | 36 |
| 14,400 to 15,360 | 2,750 | 291,243 | 68,750 | 28,157 | 388,150 | 32.5 | 36 |
| 15,360 and above | 3,000 | 300,000 | 75,000 | 30,717 | 405,717 | 34 | 36 |

DCO Electrical Loads.

| DCO Electrical Load Calculations: | | | | | | | |
|---|---|---|---|---|---|---|---|
| DCO SIZE (Lines) | Switch Load KW | Air Cond Load KW | Lights KW | Total KW | Growth Factor 1.25xKW | Generator Size KW | Transformer Size KVA |
| 1920 to 2880 | 21 | 22.5 | 1.8 | 45.3 | 56.6 | 60 | 75 |
| 2880 to 3840 | 28 | 30 | 2.4 | 60.4 | 75 | 75 | 100 |
| 3840 to 4800 | 35 | 36 | 3 | 74 | 92.5 | 100 | 125 |
| 4800 to 5760 | 42 | 45 | 4.5 | 91.5 | 114.5 | 125 | 150 |
| 5760 to 6720 | 49 | 60 | 5.25 | 114.25 | 143 | 150 | 200 |
| 6720 to 7680 | 56 | 60 | 5.25 | 121.25 | 151 | 150 | 200 |
| 7680 to 8640 | 63 | 60 | 6 | 129 | 161 | 180 | 225 |
| 8640 to 9600 | 70 | 72 | 6 | 148 | 185 | 200 | 250 |
| 9600 to 10,560 | 77 | 72 | 6 | 155 | 193.75 | 200 | 250 |
| 10,560 to 11,520 | 85 | 90 | 7.5 | 182.5 | 228 | 250 | 300 |
| 11,520 to 12,480 | 92 | 90 | 7.5 | 189.5 | 237 | 250 | 300 |
| 12,480 to 13,440 | 99 | 90 | 7.5 | 196.5 | 245.5 | 250 | 300 |
| 13,440 to 14,400 | 106 | 108 | 8.25 | 222.25 | 278 | 300 | 400 |
| 14,400 to 15,360 | 113 | 108 | 8.25 | 229.25 | 286.5 | 300 | 400 |
| 15,360 and above | 120 | 108 | 9 | 237 | 296.5 | 350 | 500 |

RSU Floor Space and Electrical Loads.

| Electrical Load Calculations: Remote Switch Units | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| RSU Size (lines) | Room Size Sq ft | AC Load KW | Switch Load KW | Lights KW | Recept KW | Total KW | Growth Factor 1.25xKW | Recommended Generator Size KW |
| 0 to 960 | 225 | 9 | 7 | 0.72 | 0.7 | 17.42 | 21.78 | 25 |
| 960 to 1920 | 350 | 9 | 14 | 1.12 | 1.05 | 25.17 | 31.46 | 50 |
| 1920 to 2880 | 500 | 15 | 21 | 1.6 | 1.5 | 39.1 | 48.88 | 50 |
| 2880 to 3840 | 600 | 15 | 28 | 1.92 | 1.8 | 46.72 | 58.4 | 60 |
| 3480 to 4800 | 800 | 18 | 35 | 2.56 | 2.4 | 57.96 | 72.45 | 80 |
| 4800 to 5760 | 1000 | 22.5 | 42 | 3.2 | 3 | 70.7 | 88.38 | 100 |
| 5760 to 6500 | 1200 | 22.5 | 49 | 3.84 | 3.6 | 78.94 | 98.67 | 100 |
| 6500 and up | over 1200 | 30 | 56 | 4.8 | 4.5 | 95.3 | 119.12 | 125 |

RSU Heat Loads.

| Air Conditioning Load Calculations: Remote Switch Units | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RSU Size (lines) | Line Cabinets | BTU/hr | Control Cabinets | BTU/hr | Rectifier BTU/hr | Misc BTU/hr | Total BTU/hr | Total Tons | Recommended AC Size Tons |
| 0 to 960 | 1 | 3,547 | 1 | 4,433 | 5,184 | 6,468 | 19,632 | 1.64 | 3 Tons |
| 960 to 1920 | 2 | 7,094 | 1 | 4,433 | 5,184 | 6,468 | 23,179 | 1.93 | 3 Tons |
| 1920 to 2880 | 3 | 10,641 | 2 | 8,866 | 7,776 | 11,788 | 39,071 | 3.26 | 3 up to 5 tons |
| 2880 to 3840 | 4 | 14,188 | 2 | 8,866 | 10,600 | 11,788 | 45,442 | 3.79 | 5 Tons |
| 3480 to 4800 | 5 | 17,735 | 3 | 13,299 | 13,192 | 14,448 | 58,674 | 4.89 | 5 up to 6 tons |
| 4800 to 5760 | 6 | 21,282 | 3 | 13,299 | 16,016 | 17,108 | 67,705 | 5.64 | 6 up to 7.5 tons |
| 5760 to 6720 | 7 | 24,829 | 4 | 17,732 | 18,840 | 17,108 | 78,509 | 6.54 | 7.5 Tons |

4.3.2 Batteries – Generally, the batteries shall be sized to support the expansion size of the switch. RUS Bulletin 1751E-302 (http://www.usda.gov/rus/telephone/regs/1751e302), Power Requirements for Digital Central Office Equipment, also recommends that the battery provided shall have the capacity to maintain the central office load for a period of 8 hours. In addition, it states that systems equipped with emergency generators are allowed to reduce the 8 hours to a 3-hour reserve time.

4.3.3 Generator. The fuel tank shall be sized for 2 days of operation. Other supporting design parameters can be found in RUS Bulletin 1751E-320 (http://www.usda.gov/rus/telephone/regs/1751e320), Emergency Generating and Charging Equipment.

4.3.4 Main Distribution Frame (MDF). The MDF is the interface between the outside plant cable and the switch cables. The iron framework of the MDF supports the horizontal blocks and vertical connectors. If new vertical sections are required, a minimum of 30 inches of clearance is required for safety.

4.3.4.1 Horizontal Blocks. The horizontal blocks terminate the tie cables between the switch and the MDF. Each connection corresponds to a telephone number on the switch. The switch contractor determines the number of horizontal blocks on the frame. All horizontals shall be stenciled to show the termination identifications.

4.3.4.2 Vertical Connectors. The vertical connectors are mounted on the vertical side of the MDF. Each connector protects 100 pairs of the outside plant cables. The connector is equipped with tip cables that are pre-terminated on the connector. The tip cables are routed from the MDF, through the floor, to the cable vault and are spliced to the outside plant cable. The vertical connectors protect the electronics in the DCO by providing lightning and surge protection. Each termination corresponds to a pair of the outside plant. All outside plant pairs shall be terminated on connectors. All verticals shall be stenciled to show the cable number and the pair count for all connectors on that vertical. All connectors shall show the count terminated. A schematic showing the vertical side of the MDF is included as Figure 4-1: MDF and Cable Vault Schematic.

4.3.4.2.1 No more than six MDF connectors shall be designed for frames less than 9 feet high.

4.3.4.2.2 No more than eight MDF connectors shall be designed for frames 9 feet high.

4.3.4.3 Cross Connects. Cross connects are installed between the outside plant terminations on the vertical connectors and the switch terminations on the horizontal blocks. This process connects an outside plant pair to a telephone number. Approximately 8 inches of slack shall be left in the cross connect wire to allow re-termination for moves, adds, or changes.

4.3.4.4 Special Circuits. Since special circuits (such as data circuits, T1s, or alarms) are usually non-switched, they shall be treated differently than voice and modem circuits. The protector modules shall be marked to indicate a special circuit. Various colors of protector modules are available to help in this differentiation. The special circuits shall be cross connected to designated blocks on the horizontal side (not to the switch blocks).

4.3.4.5 Grounding. Schematics showing the details of voice switch grounding are included on Figure 4-3: Grounding Schematic and Figure 4-4: Modified Grounding Diagram.

4.3.4.5.1 Maximum Impedance. Most manufacturers require impedance from the ground ring to earth potential of ≤ 5 ohms. Impedance measurements shall be made using a direct reading ground resistance meter.

4.3.4.5.2 Since the telephone system is usually installed by a commercial contractor and is warranted by that contractor, the system shall be grounded in accordance with the manufacturer's practices. However, the manufacturer's practices, as shown on the construction drawings, shall be reviewed for compliance with the following recommendations.

4.3.4.5.3 The components of a typical telephone central office grounding system are shown in Figure 4-3: Grounding Schematic, and include the following:

4.3.4.5.3.1 An earth electrode system, which consists of, ground rods driven into the earth around the perimeter of the switch building or in a triangular pattern in an open area just outside the switch room. These rods are exothermically bonded with a bare power wire (minimum size of 1/0 AWG). This system is commonly called the "ground ring".

4.3.4.5.3.2 The master ground bar (MGB) is usually mounted in the switch room on an outside wall and is the tie point for the ironwork, cabinet grounds, floor tile, and the reference ground for the -48V battery power plant. It is connected to the ground ring with an insulated wire, which is sized to meet the requirements of the National Electrical Code (NEC) Ordering information available at http://www.nfpa.org/products/necprods.html - 1). This system is the "single point" of the central office grounding scheme.

4.3.4.5.3.3 The cable entrance ground bar (CEGB) is a tie point in the cable vault or cable entrance area which facilitates bonding of the outside plant cable sheaths directly to the ground ring.

4.3.4.5.3.4 The MDF ground bar is a tie point for cable pair protection and is usually isolated from the MDF ironwork. The MDF ground bar is usually connected to the MGB with an insulated (minimum #6 AWG) wire.

4.3.4.5.3.5 The power distribution board is the cabinet or frame, which contains fuses (or direct current (DC) circuit breakers) for the distribution of -48V DC circuits. Its ground bar serves as a tie point for all circuit returns and the power wires to the positive side of the battery string. This ground bar is also connected to the MGB.

4.3.4.5.3.6 The battery string is a group of individual cells strapped in an amount and with a configuration which shall meet the ampere-hour requirements of the specification. The direct current is filtered by the battery string, which also provides no-break power to the switch. The positive side of the string is connected to the power distribution board ground bar.

4.3.4.5.3.7 The rectifiers, sometimes called “chargers,” convert 208V AC (commercial power) to -48V DC. The positive side of the rectifier outputs connects to the power distribution board ground bar, thus is in parallel to the battery string.

4.3.5 Cable Vault. A schematic of an MDF and cable vault is provided as Figure 4-1: MDF and Cable Vault Schematic.

4.3.5.1 Size. The cable vault shall extend the entire length of the MDF.

4.3.5.2 Layout. A center rack is preferable for the splicing of the tip cables to the outside plant cables. However, wall racking is allowable for small to medium central offices. The vault shall be designed to allow ample space for splicing of the cables. For planning, a typical vault splice is 1 foot x3 feet.

4.4 Voice Switch.

4.4.1 Terminology.

4.4.1.1 Installed Size. The total number of lines needed to support user and non-user voice outlets requiring dial tone and a unique telephone number. Installed size accounts for user population at time of startup or cutover.

4.4.1.2 Equipped Size. The total number of lines available on the installed backplane for user and non-user voice outlets when the switch is operating at its maximum installed capacity. Additional line cards may be required to reach this level. The equipped size provides for anticipated user population growth.

4.4.1.3 Expandable Size. The total number of lines available for user and non-user voice outlets when the switch is expanded to its maximum design capacity. Expandable size describes the ultimate capacity of the switch in terms of lines when all possible expansions have been accomplished. The expandable size is used in the calculations for air-conditioning, batteries, generator, and power.

4.4.1.4 Single-Line Concept. The single-line concept encompasses the requirement that each user will have a unique telephone number and a dedicated path to the telephone switch. Planners shall implement single-line concept with all new construction projects, modernization projects, and routine upgrades to the voice system.

4.4.2 Consideration Factors in Choosing Distributed Switching.

4.4.2.1 There are several basic architectural considerations in the design, upgrade, or expansion of an Army telephone system. The designer shall consider the geographical layout of the base, the availability of floor space, the existing cable routes, the existing system design, the location of the commercial telephone company point of presence, future growth, and the many other factors.

4.4.2.2 When at all possible, after consideration of the requirements and site survey of the location, a system design using one centrally located switching system is recommended. One centrally located switching system will serve a large number of subscribers more economically than multiple switches or remote switching units. The operation and maintenance (O&M) costs for HVAC and building maintenance will be minimized with this configuration. Software and hardware costs can be minimized if one central switch serves the maximum number of customers. The location of the central switch shall be considered when siting construction for new buildings.

4.4.2.3 In many cases, however, evaluation of the site data will result in the determination that one centrally located switch can not serve the entire post. If a single main switch can not serve the entire post, then a main switch with remote switching units homed to the main switch is the recommended configuration.

4.4.3 Space Limitations. Another condition that may prohibit the installation of one central switch would be lack of floor space with no possibility of additional space at the established central office site. While it is possible to change the point of presence, the local telephone company will usually charge a hefty fee for this relocation. Long established cable routes will have to be disrupted.

4.4.4 Community of Interest.

4.4.4.1 Due to the limited range of the feature telephone, a large number of users in a single building will often require a remote switching unit in that building in order to service feature telephones, even if the building is within cable range for 2500 sets.

4.4.4.2 Possible reasons or considerations for establishing a community of interest are:

a) Geographic Zones. If an area is geographically separated from the cantonment area, a remote switching unit may be more economical and easier to maintain than service from the DCO.

b) Hospital. Hospitals are treated as islands of service due to the differing types of requirements presented. Automated appointment, voice mail, and various other systems shall be considered when installing a remote unit in a hospital.

c) Security Factors. Various security factors may result in the need for a remote switching unit in a building or particular area. An example is a Special Forces compound.

4.4.4.3 Multi-Vendor Switches.

4.4.4.3.1 The O&M burden is particularly high when multiple switches are installed on a site. Each switch is considered as a separate entity by the vendor and each will require a separate software upgrade. Also, each type of switch will require a separate complement of spares. There are generally no quantity discounts.

4.4.4.3.2 If optional features are to be extended across the site, the software shall be purchased for all switches. Although switch networking software is being improved, there is generally some flexibility penalty to pay (i.e., reduced feature transparency across multiple switches).

4.4.4.3.3 Multiple switches also impose an administrative burden. In any given year, a number of personnel will be moved to different locations on post. If the move takes the user from the serving area of one switch into the serving area of another switch, changes will have to be made in the database of both switches, in addition to the jumper changes at two different locations.

4.4.5 Type of Switch Based on Size

4.4.5.1 There are typically two types of switching equipment that can be used for most applications.

a) For installations up to about 5,000 lines, there are several commercially available private branch exchange (PBX) switches that meet Army performance requirements. This PBX will be referred to as a Small Dial Central Office (SDCO).

b) For installations with initial sizes over 5,000 lines or for OCONUS locations, the selection of currently available PBXs with developed DISN software is much smaller. The larger switch will simply be referred to as the DCO.

4.4.5.1.2 The two sizes have many features in common. Both have redundant common control and supply similar user features. They differ in areas such as administrative capabilities, built-in test equipment, and trunk interfaces.

4.4.5.2 Small Dial Central Office.

4.4.5.2.1 For installations of less than 5,000 lines, small PBX equipment, with the capabilities of a PBX, as defined in Joint Interoperability and Engineering Organization (JIEO) Technical Report 8249 (Generic Switching Center Requirements), is generally installed.

4.4.5.2.2 The SDCO generally consists of one common control cabinet and a number of peripheral card cabinets. Lines and trunks are mixed within the shelves in the peripheral cabinets to load balance the system. The design is usually very compact, power efficient, and state of the art. The software is modern and very feature rich.

4.4.5.2.3 The main differences between the SDCO switch and the larger DCO switch are administrative capabilities and built-in diagnostics.

4.4.5.2.4 Trunking to the DSN is through PBX access lines. One or two specific trunks are used to support, and are reserved for only, multi-level precedence and pre-emption (MLPP). DSN interswitch trunks are not supported on the SDCO switch.

4.4.5.2.5 The maximum loop resistance design is often smaller than for the larger PBX. The loop resistance is generally dependent upon the manufacturer of the switch, but it ranges between 900 and 1500 ohms.

4.4.5.3 Dial Central Office Switch.

4.4.5.3.1 For initial installations larger than 5,000 lines, but in some cases as small as 2,000 or 3,000 lines, or for OCONUS locations, large PBX equipment, with the capabilities of an end office, as defined in JIEO Technical Report 8249 (Generic Switching Center Requirements), is generally installed.

4.4.5.3.2 The large switch typically consists of a common control cabinet, one or more switch matrix cabinets, a miscellaneous cabinet, a number of peripheral control cabinets, a trunk cabinet, and several line card cabinets.

4.4.5.3.3 The large switch has more administrative capabilities, but not necessarily more user features. It can be programmed to perform automatic outside plant cable testing during off-hours.

4.4.5.3.4 It can support DSN inter-switch trunks and thus function at a higher network level in the DISN. Any member of the DSN interswitch trunk group can be used to carry MLPP traffic.

4.4.5.3.5 Although the smaller switch product lines seem to have more rapidly adopted new manufacturing technology, the newer interfaces such as Integrated Services Digital Network (ISDN), packet, and LAN are generally fielded first and more robustly on the larger switch.

4.4.5.4 RSU Choice

4.4.5.4.1 Most of the PBX product lines have some kind of cabinet that can be remotely located to provide line cards for a remote group of users. This cabinet is supported by the common control in the main switch and usually connected by fiber optic cable.

4.4.5.4.2 The small PBX generally has the capability to remotely locate a cabinet of line cards over a limited distance. Most remote cabinets for the SDCO do not have stand-alone switching capability.

4.4.5.4.3 The larger switches have the capability to serve significantly larger remote switching units. They feature stand-alone switching capability in the event the links to the main switch are cut. They often support several thousand users at distances in excess of 100 miles.

4.4.5.4.3.1 All features available to the main switch subscribers are supported. Features are transparent to all users (same control codes).

4.4.5.4.3.2 Trunking is supported for local city trunks, but not for DSN calls.

4.4.5.4.3.3 In the stand alone mode, as occurs when links are cut, the remote switching unit does not have access to the software in the main switch; therefore, service is limited to Plain Old Telephone Service (POTS). Most of the control software for MLPP and ISDN resides at the main switch.

4.4.5.4.3.4 There are usually dialing plan restrictions that effect portability of numbers if standalone support is desired. Because of the programming complexity, stand-alone capability is only recommended for users who absolutely need immediate local telephone service.

4.4.5.4.4 Some large switches also support simple remote shelves similar to the capabilities of the smaller switch. These shelves can generally be remoted using standard multiplexing equipment. The shelves usually have no stand-alone switching capability and may or may not support electronic features or ISDN telephone instruments.

4.4.5.5 RSU vs. SLC

4.4.5.5.1 Subscriber line equipment (SLC) is now supported on several larger switches through direct interface. That is, the switch has software that allows standard remote terminal (RT) equipment to interface directly with switch T1 interface cards without the need for central office terminals (COT), line cabinets, line cards, or frame jumpers.

4.4.5.5.2 Since this interface at the switch side is still copper T1, there must be some sort of compatible multiplexer between the switch and the outside plant cable. But line cabinets and distribution frame space are not needed, so there is generally a space savings in the switch room and a cost savings in line equipment if the RT already exists. This interface is now standardized.

4.4.6 Connectivity Between Nodes

4.4.6.1 There are at least three different technologies in common use at this time: copper T-carrier, fiber optic DS3, and fiber optic Synchronous Optical Network (SONET).

4.4.6.2 Copper T-Carrier. New systems seldom use copper T-carrier, although it is possible that a small upgrade to an existing system will have to use T-carrier for logistics reasons.

4.4.6.3 Fiber Optic DS-3. Most switching systems require DS1 transmission between the main switch and the remote switching units. Transmission systems have been installed for many years that transmit one, two, or three DS3 signals over fiber optic cable between those two points. Multiplexer shelves break the high-speed signal (45, 90, or 150 megabits) into multiple DS1s for interface to the switch. At the present time, fiber optic DS3 systems are generally only used as small upgrades to existing systems.

4.4.6.4 Fiber Optic SONET Ring.

4.4.6.4.1 Most manufacturers have ring software for their SONET hardware. If ring software is in use, a break in the active fiber optic cable will not cause an outage. The system will automatically reroute traffic back over the alternate cable. All points are still connected together.

4.4.6.4.2 One of the main selling points of SONET is that it is standards based. That is, theoretically, SONET multiplexers from different manufacturers can operate together in the same system. However, many manufacturers use different methods of implementing ring software. If a ring is to be implemented, all equipment shall be the same model and run the same software load.

4.4.6.4.3 SONET rings require fiber optic cable routes that are diversely routed and physically connect the outlying sites into the ring. On a large installation, the cost of the fiber optic cable to complete the ring can total millions of dollars.

4.4.6.4.4 The problem is further compounded on larger sites by capacity issues. The ring architecture requires the entire ring to have the bandwidth to carry the sum of all the payloads of each remote site operating on the ring. At a small site with less than four nodes, a single OC12 system can be used to provide a ring. The advantage of this design is that the equipment in the central office is minimized. Only one chassis is required at the main switch to provide for four nodes.

4.4.6.5 Fiber Optic SONET Star.

4.4.6.5.1 SONET equipment operated in a star configuration is recommended for the transmission system. This architecture can generally be implemented at reasonable cost.

4.4.6.5.2 The star wired architecture is a nice fit with the structured wiring used by OSCAR for the copper distribution cables. It provides reasonable reliability at reasonable cost. Since each arm is required to carry only the traffic between the main switch and one node, ultra high-speed equipment is not needed.

4.4.6.5.3 The architecture also fits well with the design used by CUITN, so cable costs are minimized.

4.4.6.5.4 Using the star architecture also eliminates the problem of proprietary ring software. Equipment from different manufacturers can safely be mixed in the system, eliminating dependence on one vendor and allowing future replacement of equipment a piece at a time.

4.4.7 Telephone End Equipment.

4.4.7.1 Distance Limitations.  Standard 2500 sets and ISDN instruments can be located at fairly long distances (18,000 feet) from the serving switch, depending on wire gauge and loss, whereas electronic feature telephones generally have shorter reach (3,000 feet).

4.4.7.2 Features.  Electronic feature telephones and ISDN telephones are attractive to many users because they provide programmable feature buttons for ease of use and multiple lines.  The additional lines, of course, are electronic and only provisioned in software.  The instrument is served by only one or two pairs of wire regardless of the number of line appearances.  The electronic feature telephone interface is generally proprietary in nature while the ISDN set is standard, but the feature telephone is often one half to one third of the cost of an ISDN set and is therefore more often chosen.

4.4.7.3 Portability.  The feature telephone can only be used on the model switch for which it was designed and so it can not be moved from post to post unless both posts have the same switch type.  There can be problems moving even ISDN telephone sets from post to post.  The early models were not interchangeable because the programming of the multiple buttons was not standardized.

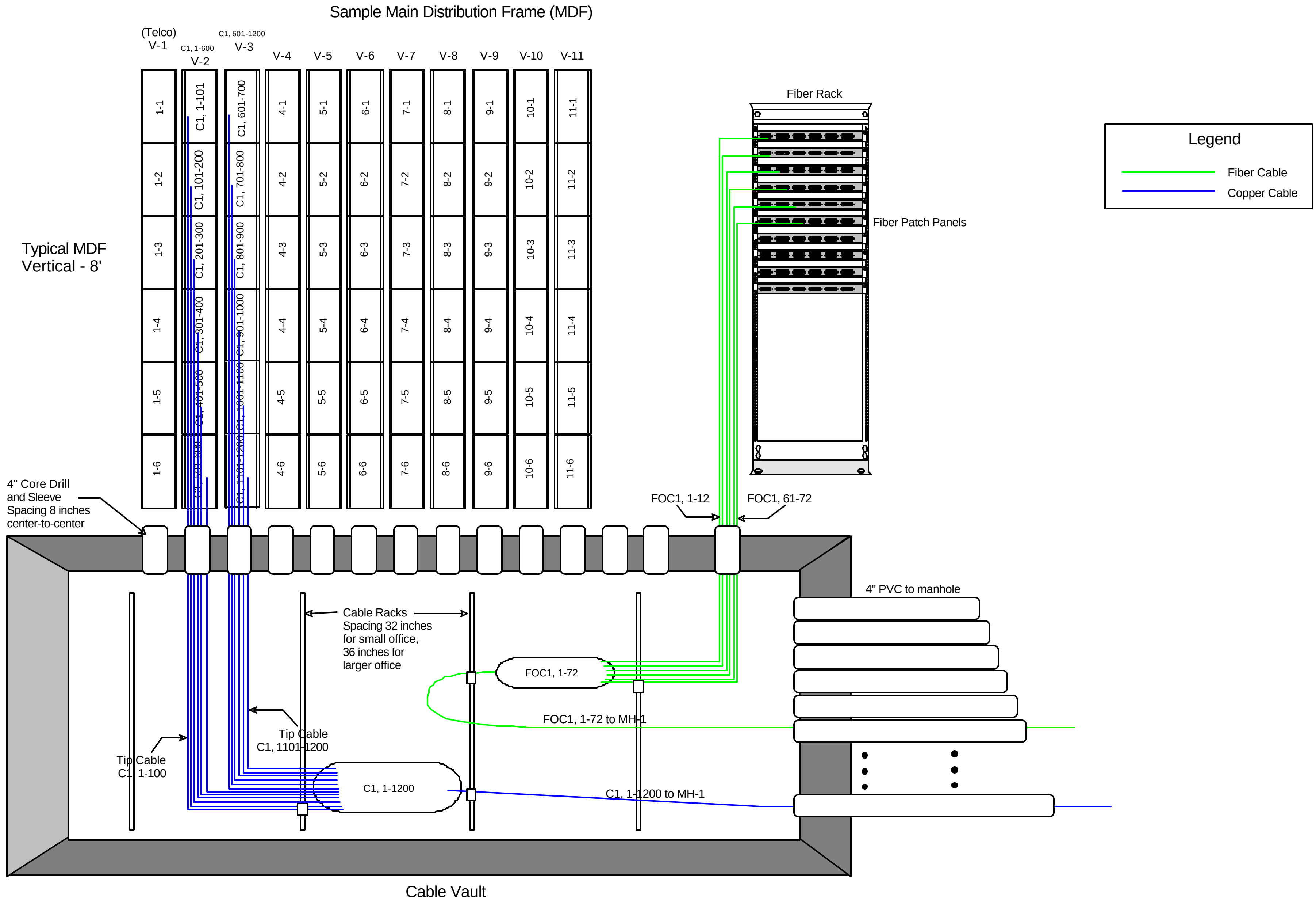



**Figure 4-1: MDF and Cable Vault Schematic**

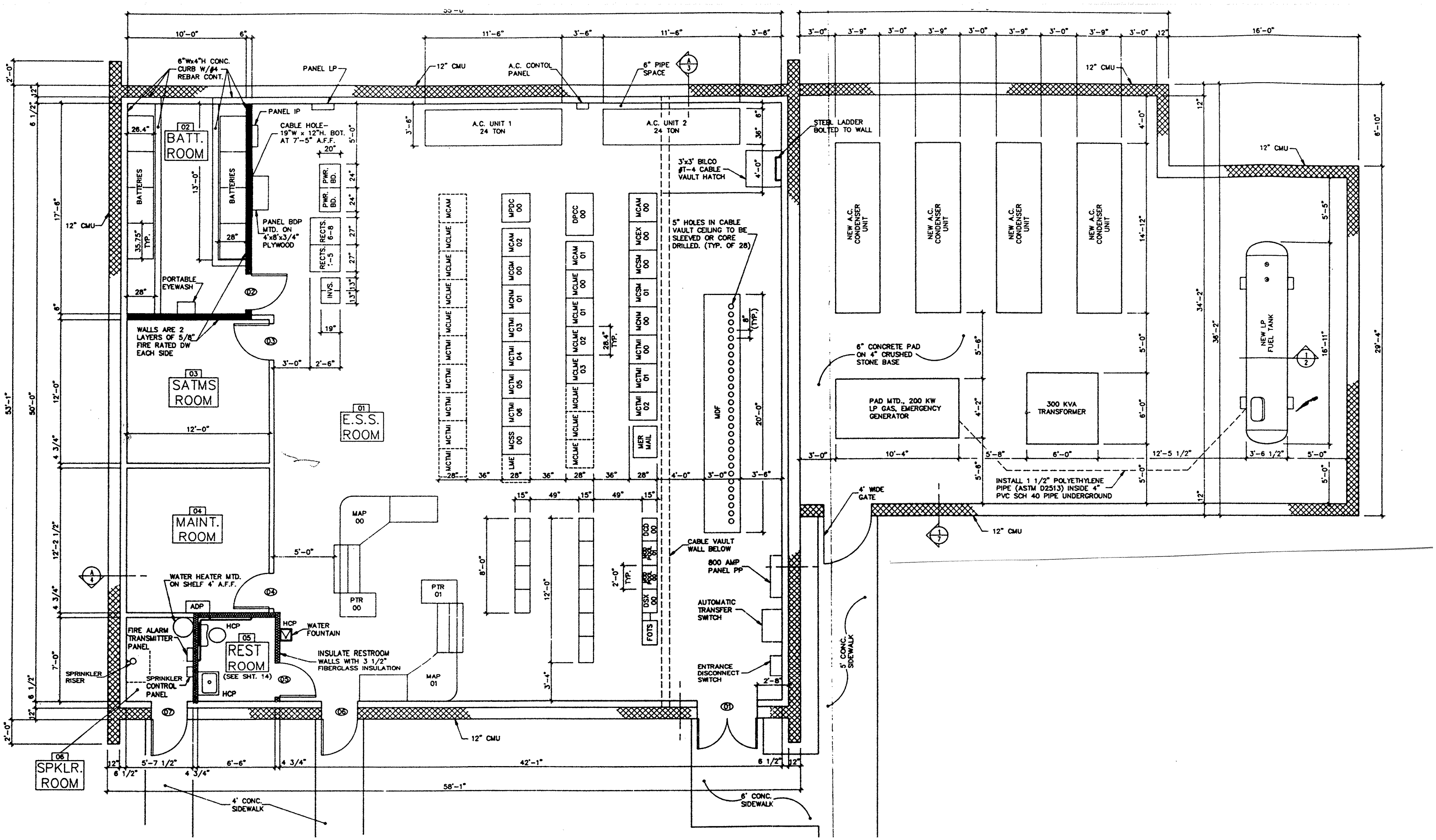


**Figure 4-2: Typical Switch Room Layout**

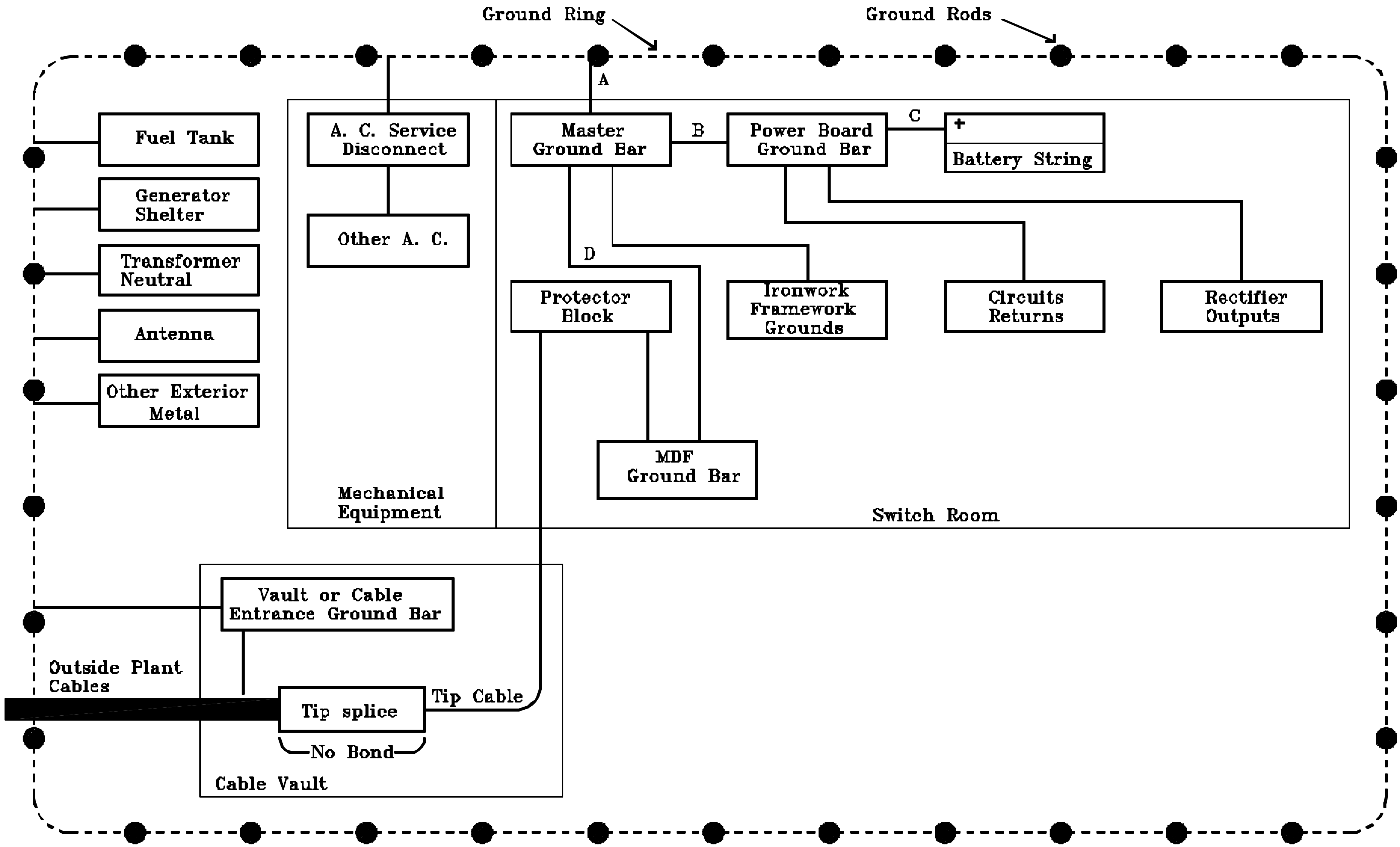



**Figure 4-3: Grounding Schematic**

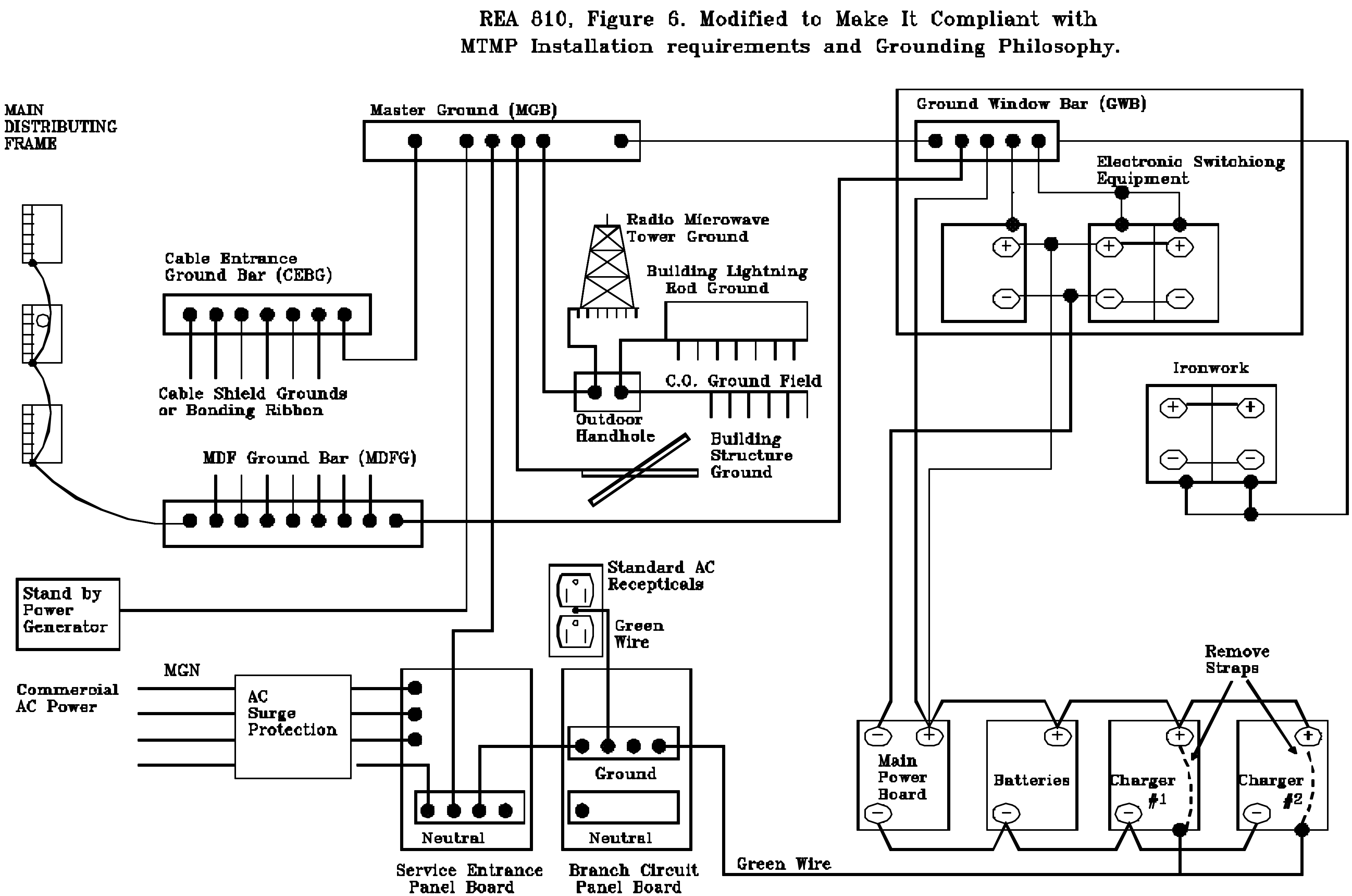



**Figure 4-4: Modified Grounding Diagram**

# 5 Network Architecture

5.1 ATM Network. The planned network architecture is based on ATM cell switches at the MCN and ADN locations, and ATM edge devices at the TCs. These ATM edge devices allow attachment of legacy switched or shared media LANs, by emulating the legacy protocols over the ATM networks. Routers can be used to interface to non-Ethernet legacy LANs, like FDDI or token-ring, and to interconnect the emulated LANs created on top of the ATM network.

5.2 Nodes. The nodes of the installation telecommunications network consist of the MCNs, ADN, and primary and secondary EUB entrance facilities. Details on the TC and user work locations/work areas are found in the Premise Distribution Systems section.

5.2.1 Main Communication Node (MCN).

5.2.1.1 The MCN houses the main telephone switch, installation main distribution frame (MDF), WAN gateway, primary installation backbone network switch, and ADN-level switch for connecting to primary EUB TCs in its local service area. The alternate MCN houses a secondary telephone switch or RSU, alternate WAN gateway, the alternate installation backbone network switch, and ADN-level switch for connections to primary EUB TCs in its local service area. Collocating the data network equipment with the central telephone switch allows for the use of the existing manholes, duct system, and fiber cable plant, and provides the ability to integrate the telephone and data backbone networks when the technology becomes available. The MCN installation backbone switch interconnects all ADN backbone switches.

5.2.1.2 The network ATM switch is typically located at the MCN and provides interconnectivity to the ADNs via point-to-point ATM link at a minimum of OC-3c rates (155 megabits per second (Mb/sec)).

5.2.1.3 Alternate MCN (A-MCN). The A-MCN at each site shall provide full backup to the MCN, with a full suite of standby equipment with automatic switch-over. The A-MCN shall be configured and connected to the ADNs identically to the MCN.

5.2.1.4 Maximization of Existing Resources. Any installation data communication network that is deployed (e.g., CUITN) shall be collocated with the existing telecommunications resources. This allows for utilization of existing manhole and duct systems, cable plant, human resources, and most significantly, the ability to utilize network resources when the telecommunication and data communication networks become integrated onto one backbone network. The MCN at each site shall be considered for use as the main point in the backbone. Because of its physical location, physical security, existing cable vaults and wiring plants, the MCN inherently lends itself as a focal point for network configuration. One network switch is typically located at the MCN and provides interconnectivity to the ADNs via point-to-point links. Figure 5-1: Main Communications Node depicts an MCN interconnection.

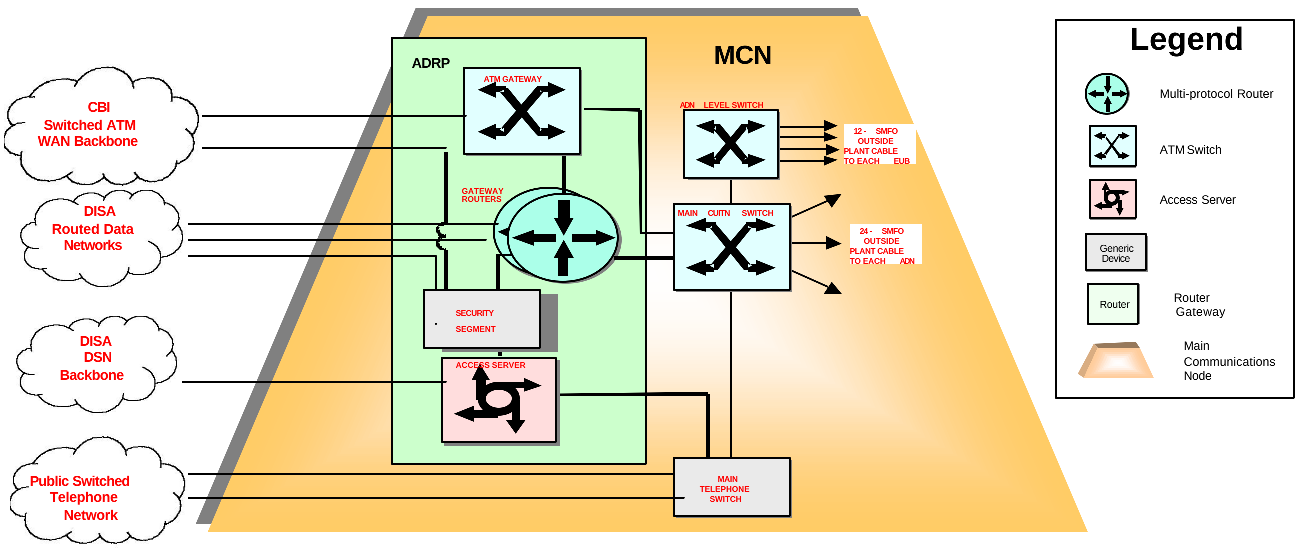



**Figure 5-1: Main Communications Node**

5.2.2 Area Distribution Node (ADN).

5.2.2.1 ADNs house the data network switches and/or the telephone RSU. They are connected to the main switches in the MCN and to switches/edge devices/hubs in each TC (Figure 5-2: Area Distribution Node). The telephone RSU and data switches/hubs shall be collocated in ADNs to concentrate the cabling and traffic from user systems in the EUBs. Locations for ADNs shall be based on both geographical considerations as well as the traffic load from the users. The maximum distance between the ADN and any customer station may not exceed a specified distance based on technology consideration cost trade-off. (Note: The current policy is for a nominal 10,000 to 13,500 feet and not to exceed 18,000 feet. These distances are based on signaling limitations of the data and telephone technologies as well as cable consolidation considerations.)

5.2.2.2 ADNs provide backbone connectivity via data switches to the EUBs over fiber optic links. The equipment located at the ADNs shall be able to provide connectivity for legacy systems as well as a migration path to future technologies. The data switch at the ADN connects the switches/edge devices/hub located in the EUB TC to the network backbone via OC-3c or higher links. ADNs will also house one-armed routers and LANE services devices, when required for support of legacy LANs.

5.2.2.3 The ATM switches at all ADNs will be connected to both the primary MCN and the A-MCN. This ATM interconnection configuration provides robust connection for capacity, scalability, full throughput, and redundancy. Every ADN will have a direct connection to the MCNs and at least two other ADNs. Reference paragraph 3.4.2.1 of the OSP for fiber cable sizing.

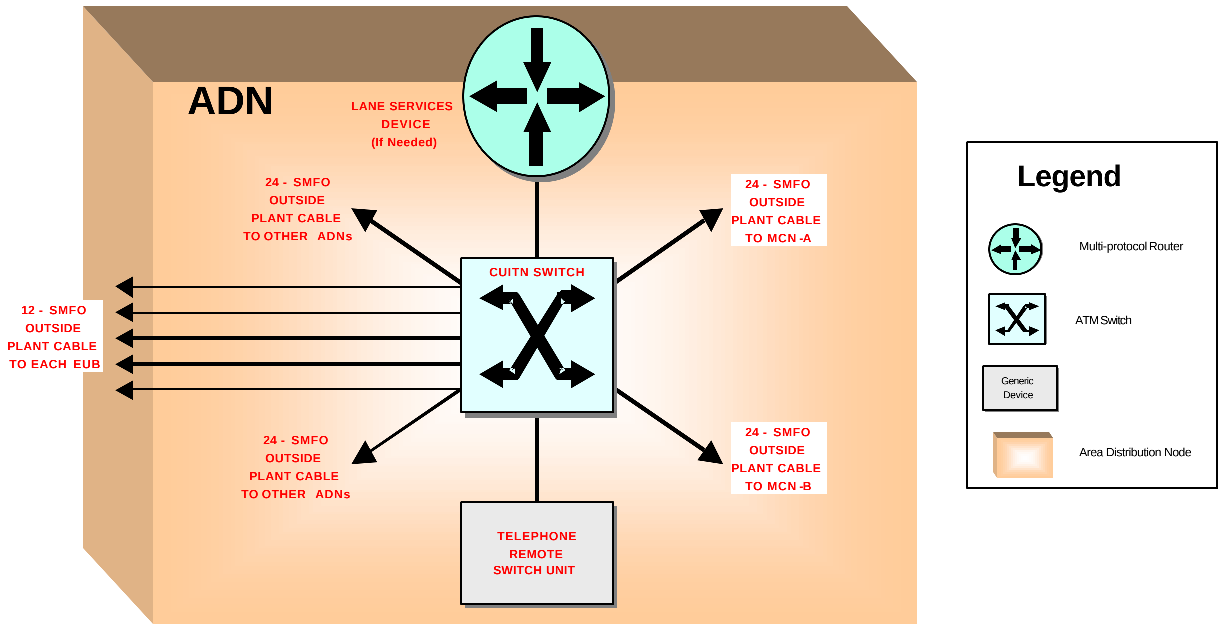



**Figure 5-2: Area Distribution Node**

5.2.3 End User Building (EUB) Entrance Facility.

5.2.3.1 Primary EUB TC. Primary EUB TCs support a full complement of data users (nominally 50), and are the termination point for the horizontal wiring with a maximum distance of 295 feet from the TC to the wall outlet. EUB TCs may concentrate telecommunications network connections from surrounding secondary EUB TCs in order to provide a cost effective distribution network.

5.2.3.2 Secondary EUB TC. Secondary EUB TCs supports a separate complement of data users. The maximum distance limitation of 295 feet from TC to wall outlet still applies. Secondary EUB TCs are connected to primary EUB TCs for connection to the installation backbone ATM network. This configuration supports efficient cable and equipment utilization.

5.2.3.3 The preferred customer premises LAN is a data hub attached to an ATM edge device located in the TC with horizontal wiring to the user workstations and single-mode fiber riser cable to the other TCs and single-mode fiber outside plant cable to the ADN. The EUB data hubs shall be of modular design to allow for growth in size and changes in technologies and bandwidth.

5.2.3.4 Figure 5-8: Typical LAN, Administrative Building shows the recommended basic components for an EUB. Stackable or small modular chassis can be used as noted on the sketch, for small user population with a small potential for growth. Uplink or high speed interfaces on the stackable hubs shall be modular to allow for changes in connection speeds.

5.2.3.5 EUB LANs can consist of existing 10BaseT shared Ethernet. Switched 10 and 100 Mb Ethernet are now widely available, with Gigabit Ethernet also emerging for building and small campus environments. The US Army is currently migrating away from Token Ring, and the designer shall consider replacing the Token Ring LAN with an 802.x switched network. Some general guidelines for designing and implementing EUB LANs are:

a) The equipment and hardware will be from manufacturers that have a minimum of 3 years experience in producing the types of systems and equipment specified.

b) The equipment shall adhere to current or emerging standards accepted by the industry (802.x, etc.).

c) The LAN electronics and software shall be fully compatible and interoperable with the existing EUB equipment, if the EUB equipment is not to be replaced.

d) Obsolete items or items no longer supported by the manufacturer shall not be utilized to fulfill the requirements in the EUB.

5.3 Description of Networks. Campus Area Networks (CANs) utilize a backbone (normally fiber optic cable,) to interconnect the LANs in several buildings or groups of buildings within a local area, such as an Army post. Metropolitan Area Network (MANs), interconnect several CANs and/or LANs usually with leased commercial lines (normally fiber optic cable) over a larger area or region such as the DoD, DA and Army installations in the Military District of Washington. WANs interconnect LANs, CANs, and MANs through a non-homogeneous mix of transport media and communications protocols, encompassing national or international areas. WANs offer a wide range of services (such as DISN and commercial services) normally not available in smaller networks.

5.4 Topology.

5.4.1 The installation backbone network shall be connected in a partial mesh topology for optimum configuration with switched technologies (Figure 5-3: Partial Mesh Topology). Interim logical bus or ring topologies can be configured using the physical star topology. The mesh connections provide survivability and load leveling.

5.4.2 A partial mesh shall be used to maintain scaleable-switched environment. At a minimum, all ADNs shall have connections to both the primary and alternate MCNs and 2 adjacent ADNs.

5.4.3 The required full time availability is achieved by using primary and alternate MCNs and connecting each ADN to both MCNs. This supports the capacity required out of each ADN and provides the required full time availability. It is highly desirable to provide diverse fiber optic cable routings so that a single cable cut/break will not prohibit ADN connections to an MCN.

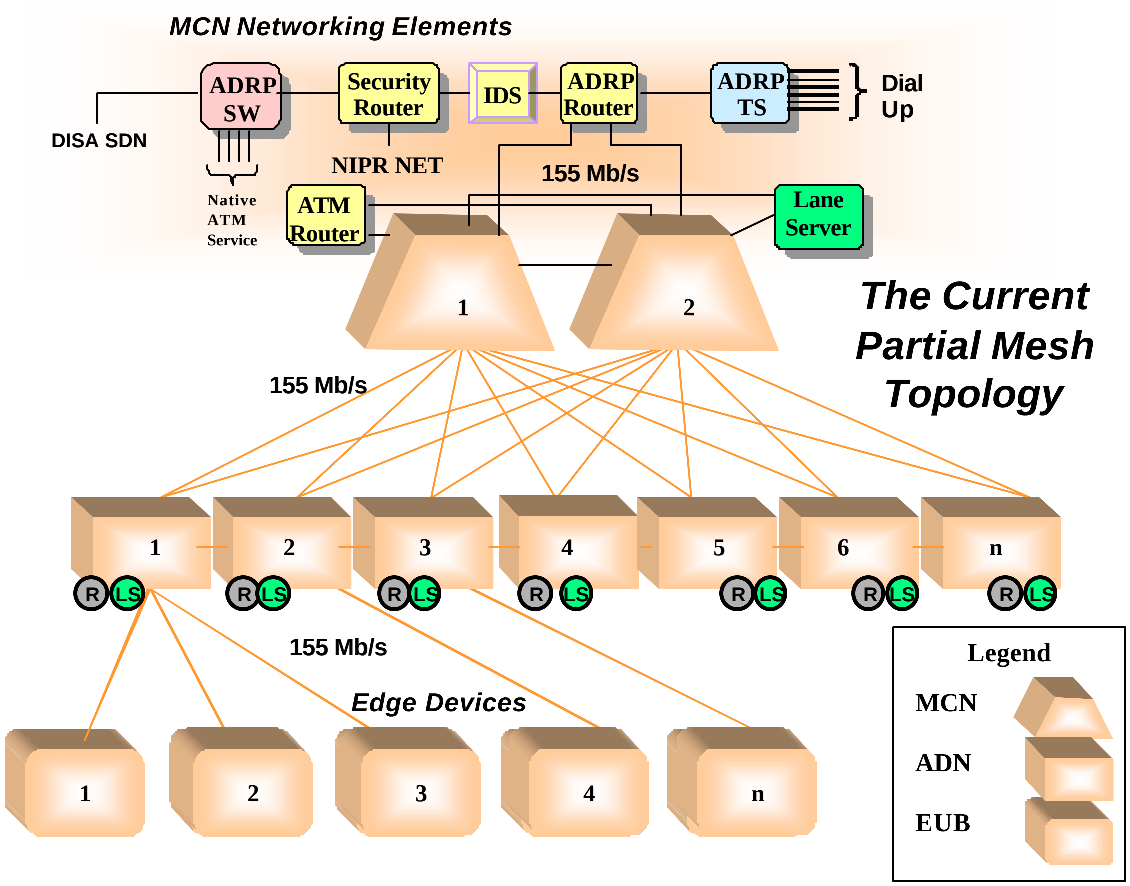



**Figure 5-3: Partial Mesh Topology**

5.5 Local Area Network (LAN).

5.5.1 On a post the LANs are data networks that normally serve an EUB and in some instances serve a limited number of EUBs. Normal LANs are designed to only serve an area that is a few square kilometers.

5.5.2 Within an EUB there are many options available in configuring a LAN. Depending on the number of end users LANs may stretch across buildings. In most cases a LAN will be established in each EUB and support about 25 to 150 end users. When EUBs have fewer than 25 users they can be tied into other EUBs and their LAN. Keeping the size of the LAN to a limited number allows optimizations to be made favoring greater data rates and placing less pressure on centrally located servers. Figure 5-4: LAN Topology is an example of a recommend LAN Topology. In this topology an EUB stacks hubs in a telecommunications closet supporting one to the variable number of floors in the building. Using this topology centralizes communications troubleshooting while isolating different floors of the LAN.

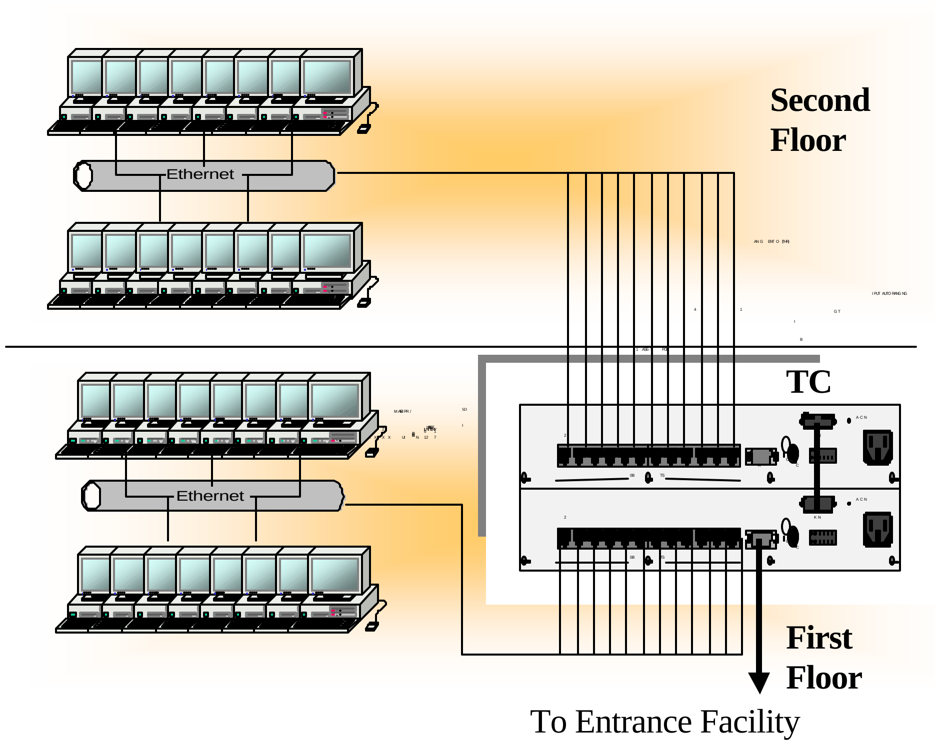



**Figure 5-4:  LAN Topology**

5.6 Alternate Types of LANs.

5.6.1    Multimode Fiber Optics LAN.  The internal LAN cable plant will consist of unshielded twisted pair (UTP) CAT5, cable or multi-mode fiber optic cable for the hub or end user device. When using fiber optic cabling the Building Entrance Facility will connect directly to the hub. Placing fiber optic patch panels within the TC may increase decibel (dB) loss affecting the performance of the fiber.  Limit the number of splices necessary in any LAN, but especially using fiber optic cabling.  Multi-mode Fiber Optics can be used in the LAN with either an ATM edge device or an Ethernet hub.  To connect to an Ethernet hub you must have a fiber card in the hub or use an Ethernet to fiber optic transceiver.  Figure 5-5.  LAN Using Multimode Fiber Optics is a diagram of a LAN using multimode fiber optic cabling and an ATM edge device. OC-3 speeds will be run into the ATM edge device.

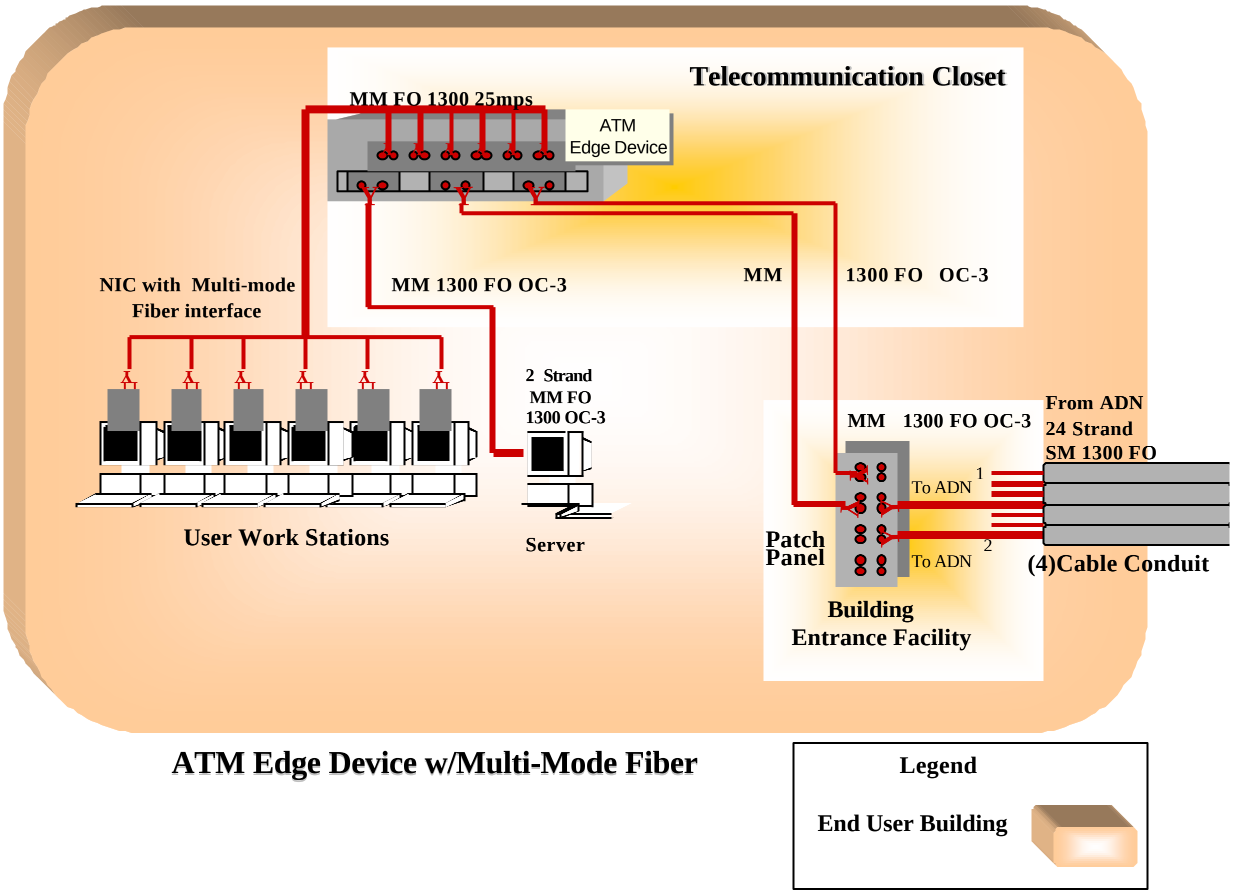



**Figure 5-5. LAN Using Multimode Fiber Optics**

5.6.2 Fiber Distributed Data Interface (FDDI) LAN. In cases where there is limited funding available to procure current data networking hardware designers can make use of existing routers. Routers that were initially placed on the backbone of a network and removed when the network was upgraded, can be moved down to an EUB and used with FDDI to improve the performance of a LAN. In order to do this it is necessary to have or install multimode fiber optic cabling from the EUB entrance facility into the router and between multiple routers used within the LAN. Figure 5-6: LAN Using FDDI shows a typical FDDI LAN.

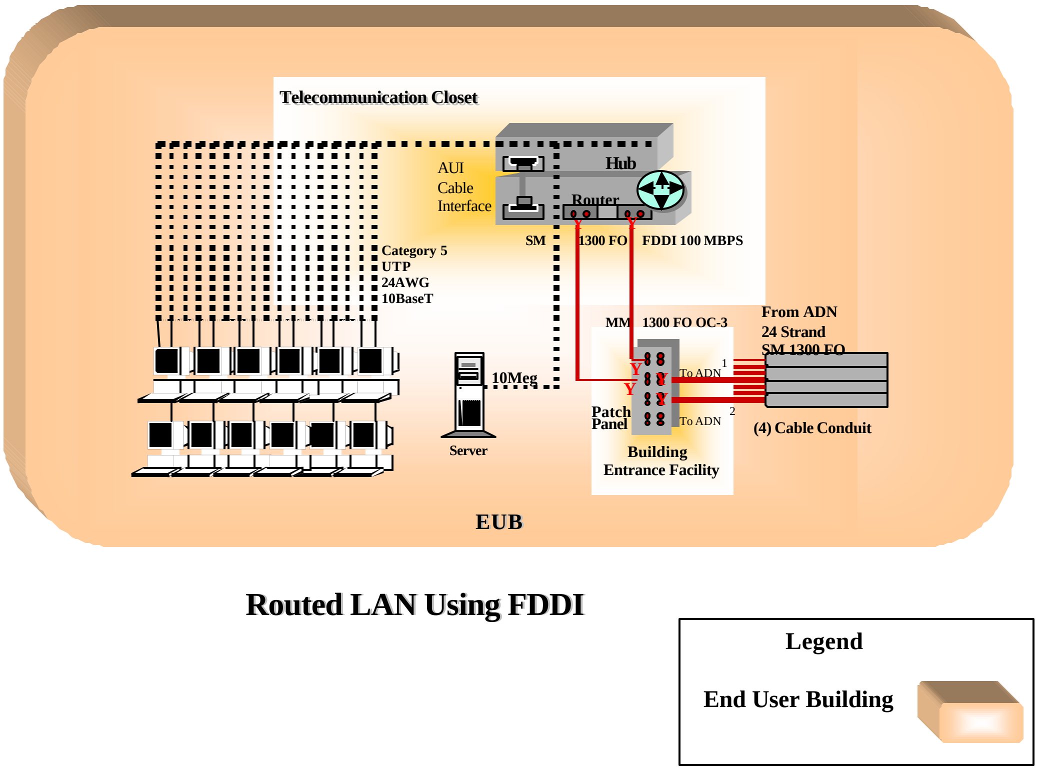



**Figure 5-6: LAN Using FDDI**

5.6.3 T1 Wire Line LAN. One way to connect buildings that do not meet the minimum essential requirement qualifications, but still need network connectivity is using a T1. A T1 connection can be made via the voice backbone using a Digital Service Unit/Channel Service Unit (DSCU/CSU) into a router. This defers cost from additional cable plant installations for data connectivity. The CSU/DSU connects to the voice patch panel via UTP and requires two pair. From the CSU/DSU a connection is made using a serial cable into a serial port on a router. The router then connects into a hub that provides Ethernet service to end users. Figure 5-7: LAN Using T1 Wire Line depicts a T1 Wire Line LAN.

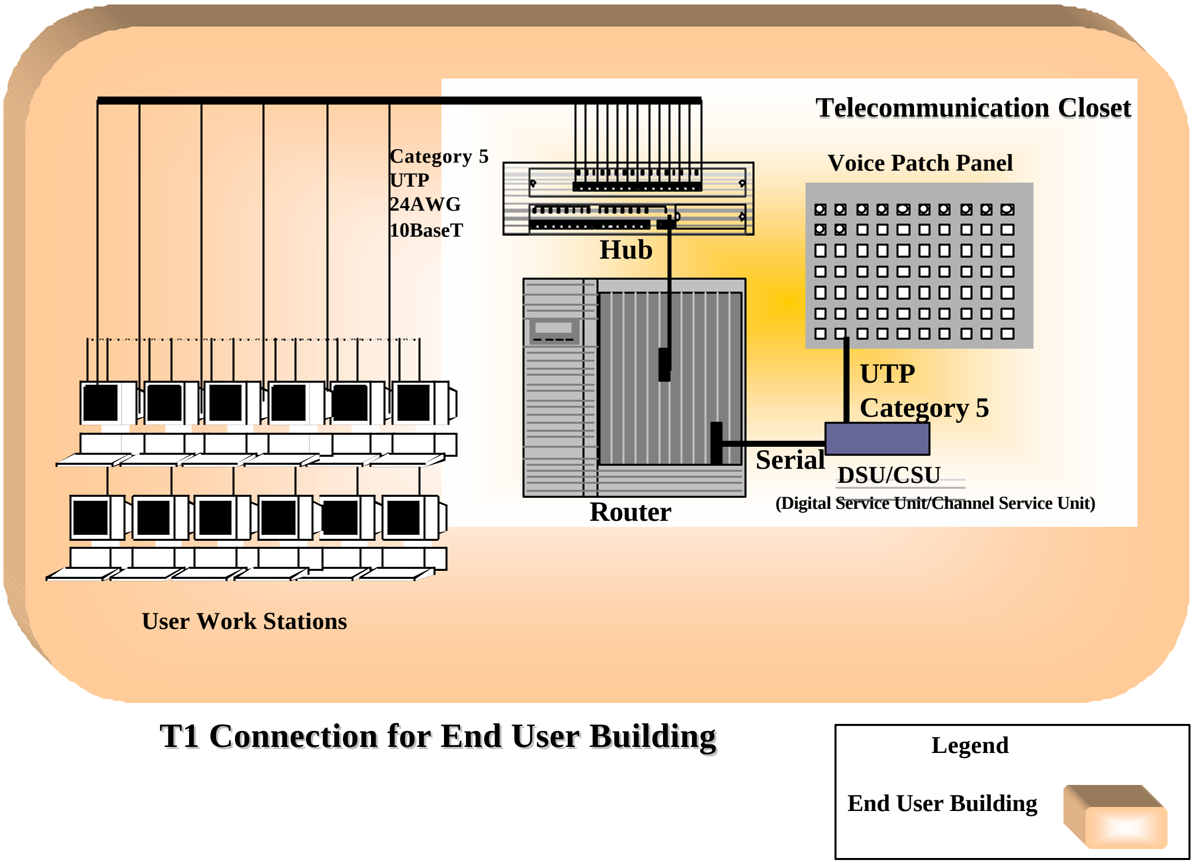



**Figure 5-7: LAN Using T1 Wire Line**

5.7 Growth. All equipment hubs (including routers and switches) will be designed with at least a 25 percent growth factor to support future system enhancements. In addition, FOC installations will be of sufficient quantity to accommodate at least a 100 percent increase in requirements.

5.8 Interfaces.

5.8.1 Data Interface.

5.8.1.1 The primary data interface between the ADN and the TC is an ATM/SONET, OC-3 signal on single-mode FOC operating at 1310 or 1550 nanometers (nm). Two separate fiber connections are required: one for transmit and one for receive.

5.8.1.2 The primary host/server interface at the ADN is an Institute of Electrical and Electronics Engineers (IEEE) 802.3 10BaseFL on multimode FOC (horizontal wiring operating at 850 and 1300 nm).

5.8.1.3 The projected future host/server interface at the ADN is a 100-Mbps IEEE 802.X or an ATM/SONET OC-3c signal on multimode FOC (horizontal wiring operating at 850 and 1300 nm) or CAT5 UTP.

5.8.1.4 An alternative data interface for existing multimode FOC is an IEEE 802.3 signal at an ST connector on multimode FOC operating at 850 and 1300 nm.

5.8.1.5 An alternative legacy LAN/host/server data interface is a FDDI at a network interface card (NIC) dual fiber connector on multimode FOC operating at 850 and 1300 nm. The multimode FOC is used for horizontal cabling to host computers or gateway devices at the ADN. Optionally, this provides the interface to existing FDDI subnetworks using existing multimode FOC.

5.8.1.6 An optional legacy LAN data interface is to extend the FDDI to a distant TC using single-mode FOC operating at 1310 and 1550 nm. Four separate connections using ST connectors are required for transmit and receive on both the "A" and "B" FDDI rings. Compatible single-mode equipment is required at both the TC and the ADN.

5.8.1.7 An alternative interface for legacy equipment with T1/T3 interfaces is an ATM cell adaptation multiplexer which converts the T1/T3 signal to an ATM/SONET OC-3c signal at an ST connector on single-mode FOC operating at 1310 and 1550 nm.

5.8.2 User Interface. Users will interface with the network system from workstations. Connection to the individual workstation will be through the EUB LAN as described above, and the Premise Distribution System. The EUB LAN is connected to the network backbone through the edge device.

5.9 Connection to Outside Plant (OSP). Data switches and edge devices connect to the outside plant through the single-mode fiber optic patch panel installed as part of the OSP distribution system. The single-mode patch panel description and locations are specified in the PDS and OSP sections of this document. The data switches and edge devices shall be collocated with the single-mode fiber optic patch panels in order to avoid having to run an extension of the fiber cabling.

5.10 Wireless Connections.

5.10.1 Current wireless LANs use one of three technologies, narrowband radio frequency (RF) signaling, spread spectrum RF signaling, and infrared light signaling as the medium between computers, the WEB, or each other. The wireless LAN can be connected to an existing wired LAN as an extension, or can form the basis of a new network. Wireless LAN implementation shall be limited to indoor locations such as manufacturing floors, hospitals and universities, where mobility is critical. The range for a typical wireless LAN system varies from under 100 feet to more than 300 feet. Data rates for the most widespread commercial wireless LANs are in the 1.6 Mbps range.

5.10.2 Three elements make up a wireless LAN: The distribution system, the access point and the portable unit or station. The distribution system will typically be an Ethernet or Token Ring wired LAN, which forms the backbone of the system. The access point is a stationary transceiver attached to a wired LAN that serves as a wired to wireless LAN bridge, or to the backbone of a wired Ethernet LAN via a simple cable. The portable unit or station can be a personal computer (PC), notebook, or any other type of input device.

5.10.3 The basic building block of the wireless LAN is the Cell. This is the area in which the wireless communication takes place. The coverage area of a cell depends upon the strength of the propagated radio signal and the type and construction of walls, partitions, and other physical characteristics of the environment.

5.10.4 The access point connects the cells of the wireless LAN with one another and connects wireless LAN cells to a wired Ethernet LAN via a cable connection to an Ethernet LAN outlet. The basic cell comprises an access point and all the associated wireless stations. The number of wireless stations per cell depends on the amount and type of data traffic. In a "busy" environment a cell might contain 50 stations while in a more "relaxed" environment 200 stations might be supported. A stand-alone cell is an ideal method of setting up a small to medium sized wireless LAN between a number of workstations or workgroups. This type of cell requires no cabling. The stations communicate with each other via the access point, which manages the data traffic in the cell. The access point functions as a bridge between the cell and the wired LAN. Stations in the cell and in other linked cells can now access all the wired LAN facilities.

5.10.5 Standards for wireless networking are being developed under IEEE 802.11.

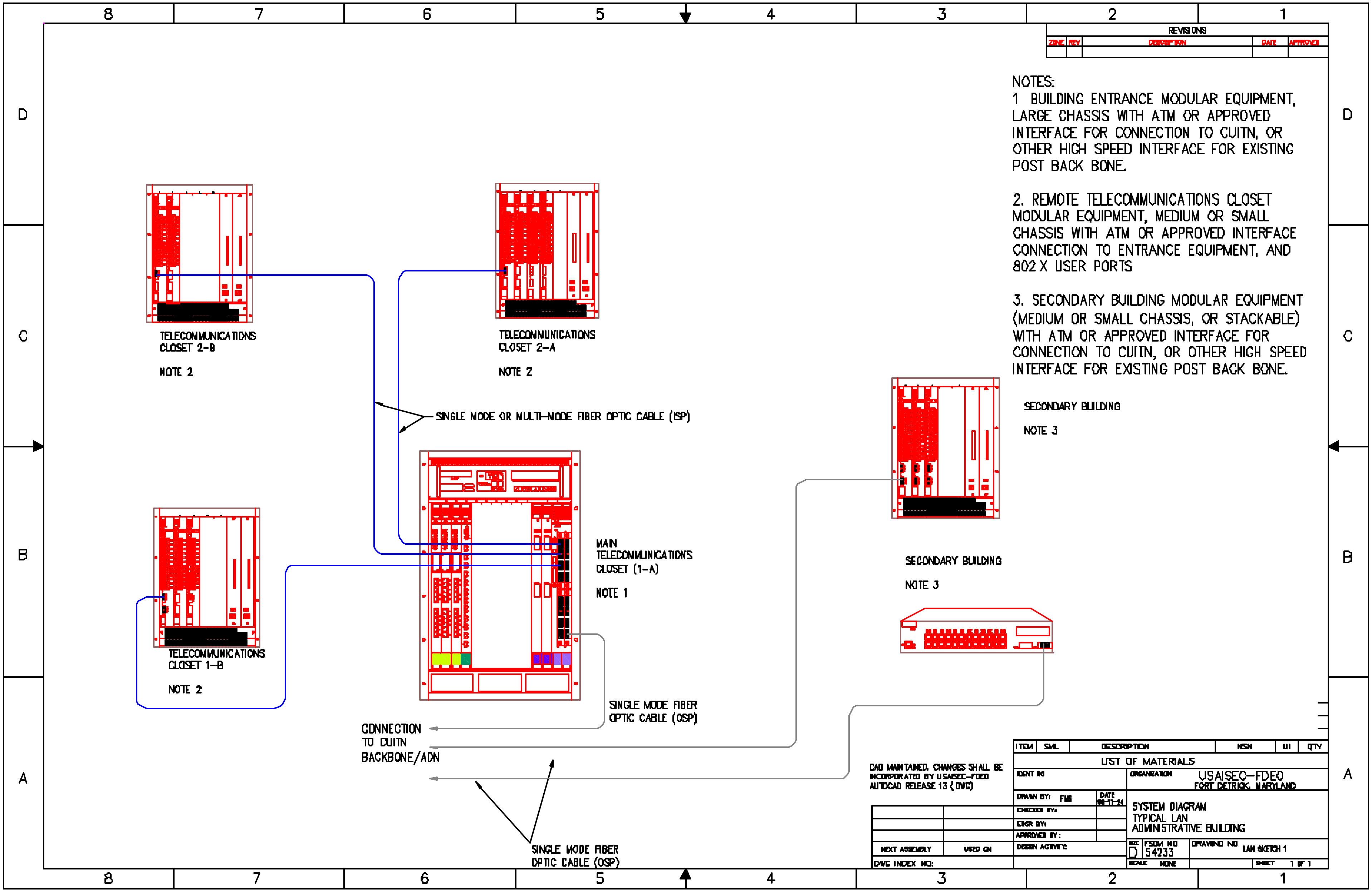



**Figure 5-8: Typical LAN, Administrative Building**

# 6 Network and Systems Management (NSM).

6.1 NSM Objective. The primary objective of Army NSM is to provide effective, responsive, and proactive management of Army I3A networks and systems with minimal life-cycle support costs. This includes the integration of management systems and subsystems to provide an enterprise view of Army network and system assets. NSM includes the five Open System Interconnection (OSI) management functional areas of fault management, configuration management, accounting management, performance management, and security management (FCAPS), as well as administration, operations, and maintenance (AO&M) functions.

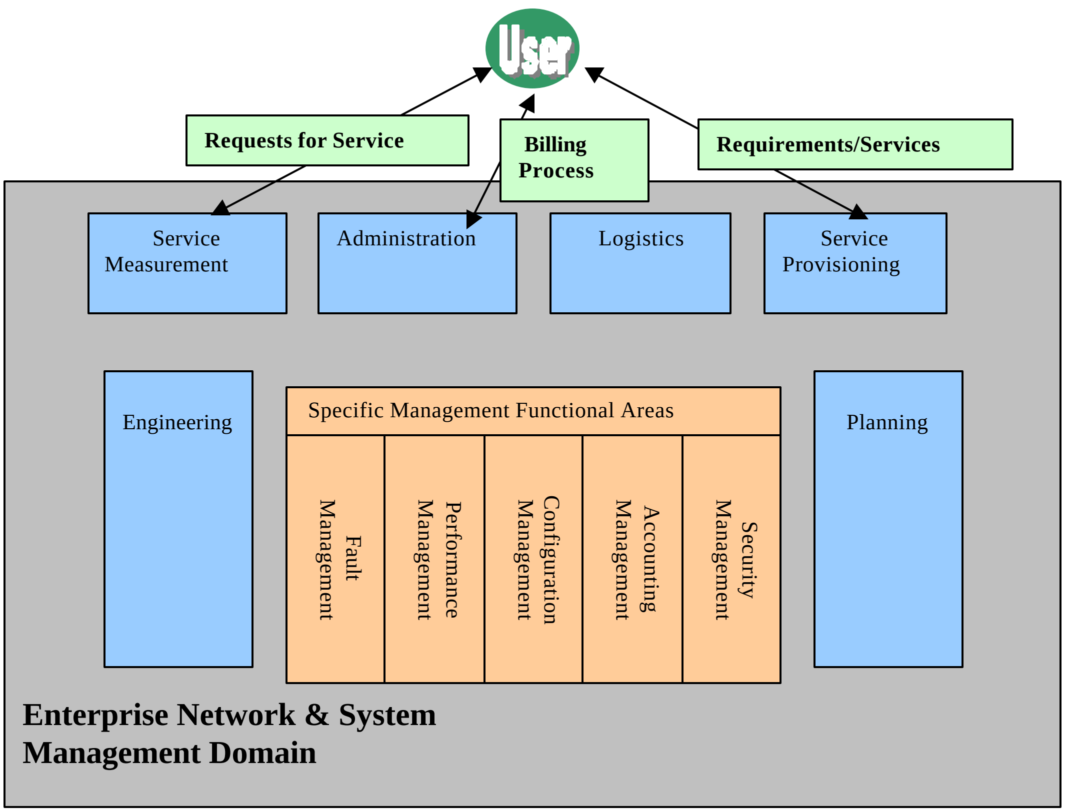



**Figure 6-1: NSM Functional Definition**

6.2 Management Functional Areas. Installations will generally have similar NSM requirements. The main difference will be that some installations will require the capability to support all or most of the management functional areas while others will only require a subset of these capabilities. Commercial-off-the-shelf (COTS) NSM tools will be utilized to the greatest extent possible to support the NSM functional areas described in the following paragraphs.

6.2.1 Fault Management. Fault management provides information on the status of the network and subnetworks to aid in the detection, isolation, and correction of problems in network and systems components. The primary benefit is an increase in network and system reliability since operations personnel are provided tools to enable them to quickly detect and correct problems.

6.2.2 Configuration Management. Configuration management aids in the identification and control of managed resources. It enhances the network and system manager's control over managed resources by providing access to important configuration data. Configuration management also includes a capability to compare the actual operational configuration with an established baseline configuration in order to detect and report discrepancies.

6.2.3 Accounting Management. Accounting management involves gathering data on the utilization of network and system resources and tracking the use of these resources by user or user group. It provides the ability to bill users, allocate resources based on usage, and plan for future network and system growth.

6.2.4 Performance Management. Performance management provides the capability to evaluate and report on the behavior of managed devices and networks. It allows network and system managers to monitor, analyze, tune, control, and report on the health of network and system components and make changes as necessary.

6.2.5 Security Management. Security management safeguards information and information systems against sabotage, tampering, denial of service, and misuse by unauthorized persons. It provides authentication, access control, encryption, and audit trail services for networks and systems.

6.3 Centralized NSM. NSM can be performed locally, centrally, or with a combination of the two (flexible NSM). Under a flexible approach, the division of labor between a centralized facility and individual DOIM is determined on a case by case basis. This will be determined by a number of factors such as technical capabilities of the local and centralized management centers, network and system requirements, and mission.

6.4 Local NSM.

6.4.1 NSM Roles of DOIM. Local NSM and touch labor is accomplished at each installation by the DOIM. DOIMs have responsibility for the information networks and systems on their installations or within an assigned geographic area. Field Manual FM 11-71 http://www.sysarch.gordon.army.mil/doctrine/manuals/fm11-71/fm11-71.htm, Network and Systems Management, defines the DOIMs NSM roles as follows:

a) Provide AO&M of the common-user information systems infrastructure on their installation or in an assigned area.

b) Provide on-site support and problem resolution coordination for devices that provide access to Army or DoD level networks and systems.

c) Share information concerning installation-level information systems or their supporting environment.

d) Implement NSM practices and capabilities in accordance with DoD, Army, and MACOM policy and guidance.

e) Establish policies and procedures for the AO&M of information systems within their area of responsibility.

f) Establish interservice support agreements with the ANSOC (Flexible NSM).

6.4.2 Benefits. NSM must be synchronized across the Army enterprise. Army programs fielding networks and/or systems to installations will coordinate NSM requirements with the

DISC4 NSM CCB, the appropriate Theater Network and Systems Operations Center (TNSOC), and affected DOIMs. This will result in the following benefits:

a) Minimize duplication of existing functionality.
b) Reduce the need for multiple NSM servers at each installation.
c) Reduce hardware and software costs.
d) Increase integration.

6.4.3 Installation NSM Servers. DOIMs will operate one or more NSM servers running a suite of COTS NSM software tools to support local NSM functional requirements as illustrated in Figure 6-2: NSM Block Diagram. The installation NSM servers will be capable of interacting with the TNSOC NSM system in order to exchange management information, as required. This will enable the TNSOCs to view the entire infrastructure in each theater and to assist DOIMs with local and/or WAN management issues. The installation NSM servers will be connected to the installation backbone data network to enable management of the installation network infrastructure. This will also enable remote monitoring and/or control of network and systems components from a centralized facility, as required. The installation NSM server software will also have the capability to filter NSM information in order to minimize traffic transmitted across the WAN to the central location.

6.4.4 Installation Managed Devices. Simple Network Management Protocol (SNMP) agents will reside on installation servers and network communications devices in order to standardize management of components across the Army enterprise. In addition, installation servers will have COTS system management agents to allow remote management of system components in the functional areas of fault, configuration, accounting, performance, and security as required.

6.4.5 NSM Interface. The primary NSM server interface will initially be 10BaseT at most installations. However, those installations that have an ATM LANE/VLAN architecture will use an ATM OC3c LANE interface for the NSM server. Two separate fiber connections will be required for transmit and receive. A separate VLAN will be setup for NSM traffic for all managed devices. Appropriate traffic filters will be installed to prevent access to this VLAN from non-authorized and non-NSM devices. Some backbone equipment (e.g., uninterruptible power systems) may require 10BaseT or 10Base FL optical fiber connections to a hub to connect to this VLAN architecture.

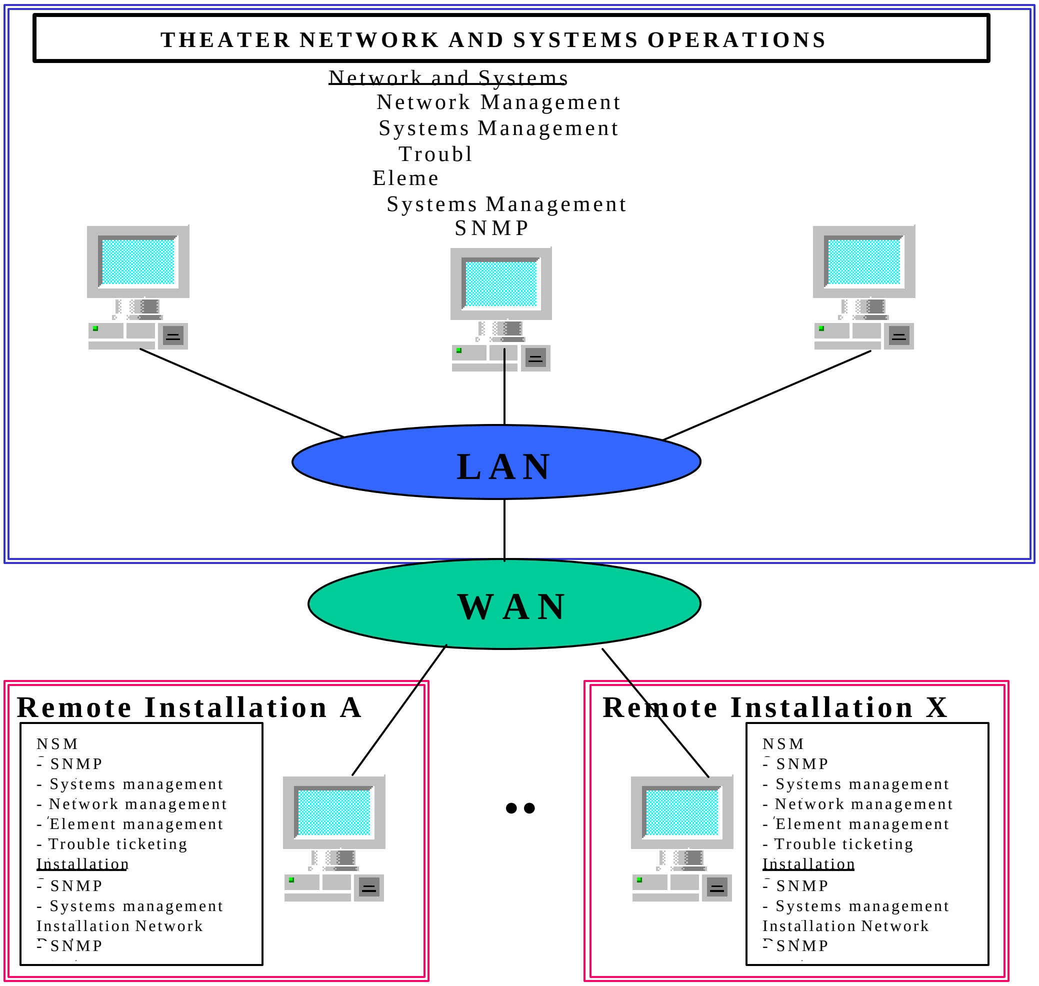



**Figure 6-2: NSM Block Diagram**

6.5 JTA-Army NSM Guidelines http://arch-odisc4.army.mil/aes/aea/jta-a/jtaa55/html/jtaa55.htm
Currently, the telephone systems and data systems are managed separately at Army installations (i.e., separate NSM servers and software for each). This is expected to gradually change over the next several years as the distinctions between voice and data diminish. The goal will be to consolidate voice and data management to the greatest extent possible. Army NSM mandates are found in Section 3 of the JTA-Army, version 5.5. Since data communications and telecommunications systems are currently following different migration paths the JTA-A breaks NSM mandates into two categories. JTA-Army paragraph 3.2.5.1 specifies the NSM standards for data communications and paragraph 3.2.5.2 specifies the NSM standards for telecommunications.

6.5.1 Data Communications NSM.

6.5.1.1 Installation network and system components will support the applicable JTA-Army SNMP mandates. Paragraph 3.2.5.1 of the JTA-Army specifies the data communications NSM standards for management stations and management agents (in end systems and networked elements). "Management stations and management agents (in end systems and networked elements) shall support the SNMP. The following SNMP-related standard is mandated: IAB Standard 15/RFC-1157,to reach the RFC site http://www.ietf.cnri.reston.va.us/rfc.html. Simple Network Management Protocol (SNMP), May 1990.

6.5.1.2 To standardize the management scope and view of end systems and networks, the following standards for Management Information Base (MIB) modules of the management information base are mandated:

a) IETF Standard 16/IETF RFC-1155, Structure of Management Information for Transmission Control Protocol/Internet Protocol (TCP/IP)-based Internets, May 1990/IETF RFC-1212, Concise MIB Definitions, March 1991.

b) IETF Standard 17/IETF RFC -1213, Management Information Base for network management of TCP/IP-based Internets: MIB-II, March 1991.

c) IETF RFC-1514, Host Resources MIB, September 1993.

d) STD-50/IETF RFC-1643, Definitions of Managed Objects for the Ethernet-like Interface Types, July 1994.

e) IETF RFC-1757, Remote Network Monitoring Management Information Base, (RMON version 1), February 1995.

f) IETF RFC-1850, Open Shortest Path First (OSPF) version 2 Management Information Base, November 1995."

6.5.2 Telecommunications NSM.

6.5.2.1 The JTA-Army, paragraph 3.2.5.2, defines the requirements for management of telecommunications voice switches. The Telecommunications Management Network (TMN) standards provide the architectural structure to manage and operate telecommunication networks and services. TMN has a layered logical architecture including the Network Element Layer, the Element Manager Layer, the Service Management Layer, the Business Management Layer, and the five Management Functional Areas similar to NSM. This structure allows telecommunication networks to be centrally managed. The TMN standards specified in the JTA-Army are listed in the following table.

6.5.2.2 Management systems for telecommunications voice switches will implement the TMN framework. To perform information exchange within a voice telephony network, the following Telecommunications Management Network framework standards are mandated:

a) ANSI T1.204, OAM&P, Lower Layer Protocols for TMN Interfaces Between Operations Systems and Network Elements, 1993.
b) ANSI T1.208, OAM&P, Upper Layer Protocols for TMN Interfaces Between Operations Systems and Network Elements, 1993.
c) ITU-TM.3207.1, TMN Management Service - Maintenance Aspects of Broadband Integrated Services Digital Network (BISDN) Management, 1996. http://www.itu.int/publications/index.html
d) ITU-T M.3211.1, TMN Management Service: Fault and Performance Management of the ISDN Access, 1996.

e) ITU-T M.3400, TMN Management Functions, 1992.
f) ISO/IEC 9595, Information Technology Open-Systems Interconnection Common Management Information Services, December 1991.
g) ISO/IEC 9596-1:1991, Information Technology -- Open Systems Interconnection -- Common Management Information Protocol (CMIP) -- Part 1: Specification.
h) ISO/IEC 9596-2:1993, Information Technology -- Open Systems Interconnection -- Common Management Information Protocol: Protocol Implementation Conformance Statement (PICS) proforma.

## 6.6 NSM References

a) DISC4 Minimum Essential Requirements (MER) statement dated 23 September 1992, SUBJ: Connectivity for the Common User Installation Transport Network (CUITN) During FY 93.

b) Installation Information Transfer System Improvement Program (I3AIP) Policy, 29 August 1994.

c) Field Manual 11-71, Network and Systems Management, Coordinating Draft, November 1998.

d) Automated Information System (AIS) Technical Guide, Network and Systems Management (NSM), Version 2, October 1998.

# 7 Security

7.1 This document concentrates on the data transport architecture for Army sustaining base operations. The security section will concentrate on the security capabilities that are rightfully the responsibility of the transport mechanism and infrastructure network. For the purposes of this discussion we will use the model architecture for discussing the appropriate places for security features.

7.2 At present there are few security features available for ATM-based networks. This is expected to change as infrastructures become more heavily invested in ATM and the user community demands security capabilities equal to, and surpassing, present routed TCP/IP-based Ethernet networks. Therefore, this architecture will discuss the requirements in terms of capabilities and leave the specific technologies out for further discussion in the implementation guides associated with specific fieldings.

7.3 Data Transport Security.

7.3.1 The Data Transport mechanism is responsible for insuring that data is delivered from the sending system to the receiving system in a manner that is timely and is free from eavesdropping and manipulation. The transport mechanism will employ devices that can enforce DA and local policies pertaining to acceptable information activities, e.g. services provided and acceptable source/destination addresses. However, the transport mechanism will largely work on the principle that it will ensure successful delivery of information, without regard for the content.

7.3.2 The Data Transport mechanism includes the physical media and connective network devices that route or switch data from end system to end system. The physical media will require protection to deny or detect any attempt to gain unauthorized access or any condition that results in a denial of service. The networking devices require protection much the same as the data processing systems described above. Physical and electronic access must be limited to those systems or individuals that require access to maintain the data transport, and no greater access. Physical security shall be strictly enforced to deny local attempts at denial or service or unauthorized access. Remote management shall only be accomplished if the system can provide for secure I&A and secure interaction.

7.4 Interfaces.

7.4.1 Gateway Interfaces.

7.4.1.1 The gateway interface is the installation infrastructure’s first line of defense against the electronic unknown. While the WAN services are provided by Defense Information System Agency (DISA), we cannot rely on them to insure that all users that cross the gateway are authorized and benevolent visitors. The gateway shall prevent obvious malicious activity from entering the installation. Additionally, the gateway interface shall limit access to the installation to those who have legitimate, authorized business in the installation.

7.4.1.2 It is incumbent upon the network to halt all traffic that is obviously of malicious intent. There are some specific commands and actions that only have the purpose of causing denial of service to the installation network or a host/server therein. These actions must not be allowed to enter the installation. There are also many protocols that are not required to extend beyond an installation. These shall be prevented from leaving or entering the gateway. Traffic that is source-addressed from a network inside of the gateway, but is originating from outside the gateway, must be halted. The implied requirement in this action is that the malicious activity can be identified both by individual data units and the composite session data. Further implied is that this information can then be used to deny entry of the data unit and the session halted.

7.4.1.3 The gateway shall limit access to the installation to those who have legitimate, authorized business on the installation. Based on positive control of all data needs of the installation any protocol and source or destination address combination that has not been identified as being required for the conduct of the installations business shall be halted. The installation data transport provider must insure that the threat condition is accounted for and access limited to the prevalent condition. It is incumbent upon the Army to identify a set of threat conditions that will be used to limit access to the installation. DISA is presently working on such a system. It is envisioned that the threat conditions will dictate the openness of the installation. Under normal conditions access may be granted to Non-classified Internet Protocol Router Network (NIPRNET) and Internet sources. In a higher threat condition access may be limited to just NIPRNET users. In the highest level of threat condition access may be limited to that subset of activity that has been previously identified as being critical to the accomplishment of the Army's mission. These determinations have yet to be made but the gateway interface must be capable of rapidly supporting multiple access profiles. Establishment and maintenance of authorized users, protocols and activities will require the active involvement of the Security Management Operations Center (SMOC).

7.4.1.4 Physical security is an important aspect of gateway interface security. Access to the gateway devices must be limited to those individuals that require access to perform authorized function. Electronic access needs to be conducted over a secure link after proper identification. Across multiple installations care must be taken to insure that identical passwords are not used at various locations. A system of one-time passwords shall be implemented across the Army.

7.5 Area Distribution Node (ADN).

7.5.1 The ADNs have the same requirements as the gateway interface. However at this level the granularity of the detail can become much finer. Whereas the installation gateway had to accommodate all required interfaces across the installation, the ADN can be limited to only those requirements within the scope of the ADN.

7.5.2 End User Building (EUB). Like the ADNs, the EUB network devices have the same requirements as the Interface Gateway. The granularity at this level shall have a high level of precision that allows for very specific filtering that matches specific data interfaces. It is important that the Infrastructure Network managers maintain the network devices in the EUBs. This will allow for a configuration managed solution to be incorporated throughout the infrastructure.

7.6 Relationship Between Data Transport Security Responsibilities and System Security Responsibilities.

7.6.1 It is incumbent upon the data transport system to insure timely, reliable delivery of data. However, the data that is delivered can only be as reliable as that inserted into the transport system. The reliability of that data is directly related to the security of the system that uses the data transport mechanism.

7.6.2 The installation infrastructure manager must insure that the networks linked into the End User Buildings meet minimum connectivity requirements. The minimum standards must define host/server requirements and limit the interfaces that the end systems may have. Minimum C2 Protect mechanisms much be incorporated into the end systems. Physical and business practice security must be enforced prior to connectivity to the installation infrastructure. Additionally, connectivity requirements must be identified by the end system to the End User Building network administrator. The End User Building network administrator will compile this information and roll it up to the infrastructure network administrator so that interface requirements can be translated into access controls.

7.7 Secure Infrastructure Services.

7.7.1 The Installation Infrastructure has a responsibility to provide a secure networking environment in which systems can safely operate. In addition to the security specific functionality described above there are also key services, which are properly in the domain of the Installation Infrastructure, which must be secure. These services are typically those that are required for maintaining a secure, operating infrastructure.

7.7.2 Address to Name Resolution. Address to Name resolution, currently embodied in Domain Name Service (DNS), is a central component of an infrastructure that allows human understandable addresses to be translated to specific hardware or protocol addresses that is understood by the transporting mechanism. A breach of security in this area could allow a threat actor to either reroute traffic entirely to the wrong address or to surreptitiously copy traffic to a listening post address. Either of these is totally unacceptable and must be prevented. Typical security functionality that will be used here is server hardening, intrusion detection, limited access, and automated mechanisms that will direct inquiries away from a suspect server to a known good backup server until the suspicious activity can be reconciled.

7.7.3 Remote Access. It will likely remain a requirement that users who are distant from their installation infrastructure will require access back to their home station. Circumstances will require that remote access be obtained through means other than direct network connectivity. For the foreseeable future dial-up remains the most likely means of reaching back to the home installation. Unregulated dial-in access can pose serious security vulnerabilities to the infrastructure. In order to prevent this, the installation infrastructure will be required to provide for centralized remote access. The infrastructure will employ a series of dial-up servers that will centrally authenticate the remote users. Upon authentication the remote users will be granted network access privileges based on the user remote privileges defined in Central Authentication Server. The infrastructure network will employ a capability to regulate access based on user privileges. Access attempts beyond authorized privileges will cause the current access to be terminated and will flag the database to temporarily deny access to the user until the situation can be resolved. As part of this capability a system will be put in place to monitor remote access network activity for actions that are detrimental to the network or systems. Security provisions at this network access point will be similar to those at the gateway interface.

7.7.4 Installation Security Management. The installation will be required to man an established Security Management Operations Center (SMOC). This SMOC may be integrated into the Network and Systems Management Center. However, if it is, the leader of the SMOC must have a separate reporting line to the responsible commander. This will enforce the basic Army premise that personnel responsible for security cannot be the same personnel who are responsible for ensuring that the system is operational. There are many benefits to a combination of Network, Systems, and Security Management. Many problems are initially observed as one type of problem but may affect the other areas. Likewise, correcting a security problem usually involves the network or system operators. Functions of the SMOC include management of access control features, intrusion detection monitoring and correlation, security upgrades, and coordination with Army and Regional Computer Emergency Response Teams.

7.7.5 Central Authentication Server (CAS). The installation infrastructure will be responsible for developing and maintaining a single, central, authentication server database. This CAS will maintain a complete database of all authorized users on the installation and their associated privileges. Single sign-on will also be employed on the installation and access coordinated with the CAS. Due to the power of the CAS it will require server hardening and additional security features that prevent modification of unauthorized access to, or denial of service of the CAS.

7.7.6 Microsoft New Technology (MS NT) Domain Controller. Though it would be best to avoid discussing specific technologies in this paper this is an area where it cannot be avoided. The infrastructure of the near future will employ to a certain degree MS NT. An inherent feature of the NT networking is the concept of Domains. Presently there is no central authority for the establishment and management of Domains on installations. The installation of the future must have centralized Domain control to properly regulate trust relationships. Without central control the trust relationships become difficult to manage and are no longer under the control of the original domain. Like the CAS and DNS, the NT Domain Controller must be hardened and have additional safeguards to identify attempts at unauthorized access, modification or denial of service. Automatic roll over to a secure backup Domain Controller must be envisioned.

7.7.7 Public Key Infrastructure (PKI). The need for an Army wide Public Key Infrastructure has been identified within the DoD and DISA has taken the lead to implement. Presently there are plans for DISA to release the first set of implementation guidance documents in 2QFY99. When this documentation is published this architecture will be updated to provide additional details. For now, it will be sufficient to say that the installation infrastructure will be responsible for providing installation level PKI activities. No other PKI initiatives will be permitted, without, DISC4 waiver.

7.7.8 Physical Security. In addition to the electronic and protocol aspects of information assurance the issue of physical security becomes critical in a fixed infrastructure. As has been documented in the early sections of this architecture the cable plant and associated equipment, e.g., manholes, ducts, distribution centers and Telecommunications Closets, all become single points of failure for buildings, organizations, or the entire installation. Very close attention must be paid to physically secure these locations from ground attack, acts of God, or unintentional activity. Typically Telecommunications Closets and distribution centers are contained in reasonably secure facilities. However, the campus cable run is typically left unprotected as it runs across the installation. A single malicious individual, or a coordinated assault on the ducts and manholes housing the installed cable, can quickly disrupt or destroy the transport capability. As a prelude to specific or general hostilities this would be devastating on the installations ability to respond to a crises. Therefore, a great deal of attention shall be provided to insure that the appropriate physical security specialists have analyzed the various facilities and cable routing and applied appropriate physical security. The specific physical layout of the wiring and distribution capability needs to clearly indicate the location of the support mechanisms for high profile organizations. Further analysis shall be given to identifying those locations that become high risk due to the exposed nature of the duct work or manholes, or where the cabling becomes concentrated and a single act could cause greater damage.

7.7.9 Wireless Connection Security. As addressed in paragraph 5.10 Wireless Connections are become somewhat common place on Army installations. Prior to designing a Wireless LAN or other wireless connection specific attention must be paid to various areas of information assurance. Most of today's data used by the Army has been deemed to be Sensitive, But Unclassified (SBU). All SBU data, in accordance with AR 380-19, must be encrypted. Care must be taken to select a solution that satisfies AR 380-19 encryption requirements or appropriate Risk Management Reviews and waivers must be obtained. In addition to the privacy afforded by encryption, additional consideration must be given to OPSEC and criticality of service availability. An analysis shall include considering whether or not the intended environment, e.g., retail or wholesale logistics points, can be used as an indicator of military preparedness. Even with encryption the level of data transmission might indicate a heightened state of activity which could be used, along with other indicators, to confirm a specific readiness activity. Additionally, analysis must be given to determine if the function being accommodated by Wireless Connections is critical to the operational mission of the organization. If it is critical, then care must be taken to insure that simple jamming activities cannot be used to create a denial of service. Solutions may include the use of spread spectrum technologies, frequency hopping, or a good Continuity of Operations Plan (COOP) status that can easily be implemented without significant loss of function.

# 8 List of Acronyms and Abbreviations

| Acronym | Definition |
|---|---|
| AC | alternating current |
| ADN | Area Distribution Node |
| ADRP | Army DISN Router Program |
| AFH | Army Family Housing |
| AIS | Automated Information System |
| A-MCN | Alternate Main Communications Node |
| AO&M | Administration, Operations, and Maintenance |
| ATM | Asynchronous Transfer Mode |
| AWG | American Wire Gauge |
| BCA | BRAC Construction-Army |
| B-ISDN | Broadband Integrated Services Digital Network |
| C3I | Command, Control, Communications, and Intelligence |
| CAS | Central Authentication Server |
| CAT5 | Category 5 |
| CATV | Cable Television |
| CCTV | Closed Circuit Television |
| CEGB | Cable Entrance Ground Bar |
| CEGS | Corps of Engineers Guide Specification |
| CONUS | Continental United States |
| COT | Central Office Terminal |
| COTS | Commercial Off-The-Shelf |
| CP | Consolidation Point |
| CUITN | Common User Information Transport Network |
| DA | Department of the Army |
| DC | direct current |
| DCO | Dial Central Office |
| DDN | Defense Data Network |
| DISA | Defense Information Systems Agency |
| DISN | Defense Information Systems Network |
| DNS | Domain Name Service |
| DoD | Department of Defense |
| DoDD | Department of Defense Directive |
| DoDI | Department of Defense Instructions |
| DOIM | Director of Information Management |
| DPW | Director of Public Works |
| DSN | Defense Switching Network |
| DSSMP | Digital Switched Systems Modernization Program |
| EIA | Electronics Industry Association |
| EMT | Electrical Metallic Tubing |

| Acronym | Definition |
|---|---|
| EUB | End User Building |
| FDDI | Fiber Distributed Data Interface |
| FOC | Fiber Optic Cable |
| GSP | Galvanized Steel Pipe |
| HVAC | heating, ventilation, and air-conditioning |
| I3A | Installation Information Infrastructure Architecture |
| ICEA | Insulated Cable Engineers Association |
| IEEE | Institute of Electrical and Electronics Engineers |
| IMA | Information Mission Area |
| IS | Information System |
| ISDN | Integrated Services Digital Network |
| JIEO | Joint Interoperability Engineering Office |
| JTA | Joint Technical Architecture |
| JTA-A | Joint Technical Architecture-Army |
| LAN | Local Area Network |
| LANE | Local Area Network (LAN) Emulation |
| M | meter |
| MACOM | Major Command |
| Mbps | megabits per second |
| MCA | Military Construction-Army |
| MCN | Main Communications Node |
| MDF | Main Distribution Frame |
| MGB | Master Ground Bar |
| MIB | Management Information Base |
| MLPP | Multi-Level Precedence and Pre-emption |
| MPOA | Multiple Protocols over ATM |
| MS NT | Microsoft New Technology |
| MUTOA | Multi-User Telecommunications Outlet Assembly |
| NIC | Network Interface Card |
| NIPRNET | Non-Secure Internet Protocol Router Network |
| N-ISDN | Narrowband Integrated Services Digital Network |
| NSM | Network and Systems Management |
| O&M | operations and maintenance |
| OCONUS | Outside Continental United States |
| ODISC4 | Office of Director of Information Systems Command, Control, Communications and Computers |
| OSCAR | Outside Cable Rehabilitation |
| OSI | Open System Interconnection |
| OSP | Outside Plant |
| OSPF | Open Shortest Path First |
| PBX | Private Branch Exchange |
| PC | Personal Computer |
| PDS | Premise Distribution System |
| PET | Protected Entrance Terminal |

| Acronym | Definition |
|---|---|
| PKI | Public Key Infrastructure |
| P-MCN | Primary Main Communications Node |
| POTS | Plain Old Telephone Service |
| PVC | polyvinyl chloride |
| RF | radio frequency |
| RSU | remote switching unit |
| RT | remote terminal |
| RUS | Rural Utilities Service |
| SDCO | Small Dial Central Office |
| SLC | subscriber line carrier |
| SMOC | Security Management Operations Center |
| SNMP | Simple Network Management Protocol |
| SONET | Synchronous Optical Network |
| TAFIM | Technical Architecture Framework for Information Management |
| TC | Telecommunications Closet |
| TIA | Telecommunications Industry Association |
| TMN | Telecommunications Management Network |
| TNSOC | Theater Network and Systems Operation Center |
| UL | Underwriters Laboratory |
| UTP | Unshielded Twisted Pair |
| VLAN | Virtual Local Area Network |
| WAN | Wide Area Network |
| WWW | World Wide Web |

# 9 Legend for I3A Symbols.

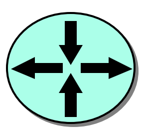
**NODES**

**Main Communications Node**

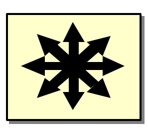
**Area Distribution Node**

**End User Building**

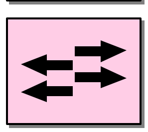
## Communication Device Symbols



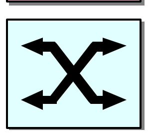
Multi-protocol Router



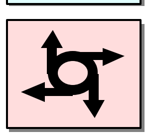
Multi-layer Switch



LAN Switch

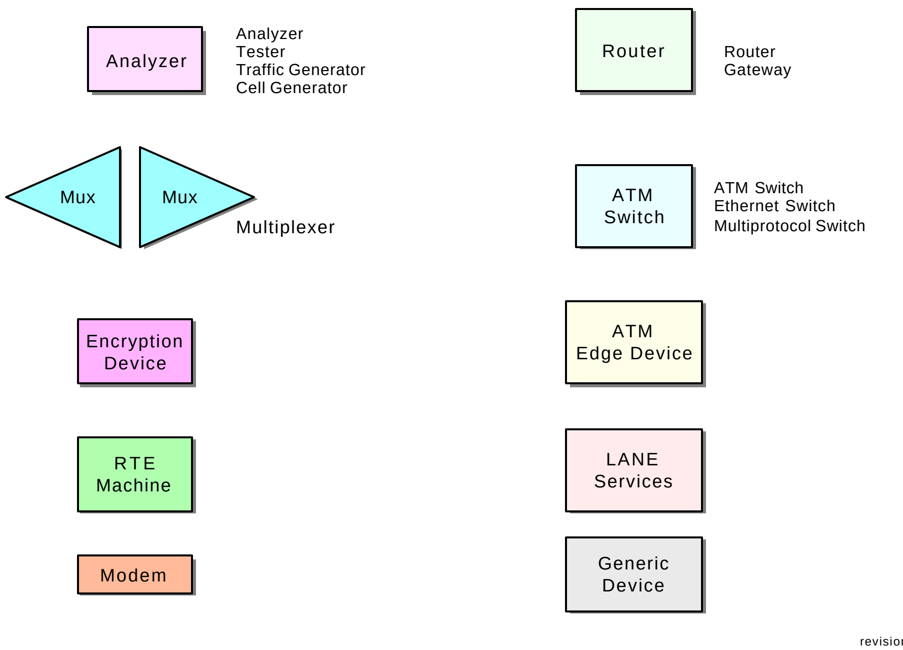


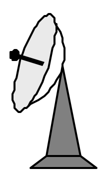
ATM Switch



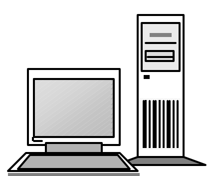
Access Server

## Generic Comm Devices

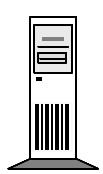


Satellite, Wireless



Workstation, Server, Network Mgmt Station



Mail Host or Server